State of Connecticut

PUBLIC DOCUMENT No. 24

FIFTY-THIRD REPORT

OF THE

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

NEW HAVEN

FOR THE YEAR

1929

PRINTED IN COMPLIANCE WITH STATUTE

NEW HAVEN
PUBLISHED BY THE STATE
1929

Publication
Approved by
The Board of Control

THE TUTTLE, MOREHOUSE & TAYLOR COMPANY,
NEW HAVEN, CONN.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

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As of October 31, 1929

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CONTENTS

Page

Letter of Transmittal and Report of the Board of Control v
Report of the Treasurer vii
Report of Insect Pest Appropriation x
Report of Mosquito Elimination Appropriation xi
Report of Tobacco Research Appropriation xii
Report of White Pine Blister Rust Appropriation xiii
Report on *Inspection of Commercial Fertilizers, Bulletin 308* 1
Fifty Years' *Index, 1877-1927, Bulletin 309* *107*
Canada-Leaming Corn, Bulletin 310 185
Report of the Tobacco Substation, Bulletin 311 197
Thomas B. Osborne, A Memorial, Bulletin 312 275
The Oriental Peach Moth in Connecticut, Bulletin 313 395
White Pine Blister Rust Control in Connecticut, Bulletin 314 ... 451
Report of the Connecticut State Entomologist, Bulletin 315 479
A Maple Leaf Disease Caused by Cristulariella Depraedans, Bulletin 316 621
Report on Inspection of Commercial Feeding Stuffs, Bulletin 317 649
Report of the Director, Bulletin 318 749
Report on Food and Drug Products, Bulletin 319 773
The Soils of Connecticut, Bulletin 320 823
Index 913

CIRCULARS:

The European Corn Borer, Quarantine and Clean-Up Regulations, Circular 68 I
European Black Currants Outlawed, Circular 69 IX
Nursery Sanitation Zones, White Pine Blister Rust Control, Circular 70 XIII
Regulations Concerning the Transportation of Nursery Stock in the United States and Canada, Circular 71 XXV
Quarantine Regulations Affecting the Transportation of Nursery Stock in Connecticut, Circular 72 LV

LETTER OF TRANSMITTAL

AND

REPORT OF THE BOARD OF CONTROL

To His Excellency, John H. Trumbull, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station herewith submits its Fifty-Third Annual Report, for the year ending October 31, 1929. The financial reports covering the several appropriations appear on pages vii-xiii.

A general statement on the work of the year will be found in the Report of the Director (pages 749 to 771), which was issued as Bulletin 318.

The Report for this year consists of 17 bulletins, each dealing with a particular phase of the Station's activities. Of unusual interest are the "Fifty Years' Index" (Bulletin 309) prepared by Dr. Jenkins, and the Memorial to Dr. Thomas B. Osborne (Bulletin 312), in whose death on January 29, 1929, the Station suffered a great loss.

The General Assembly of 1929 made some small increases in the several Station appropriations. In the case of the Insect Pest Appropriation no increase was made, with the result that the Entomologist has been obliged to ask for certain special allotments to take care of the outbreaks of the Oriental peach moth, the Japanese beetle, and the European corn borer.

On February 13, 1929, occurred the death of Mr. Charles R. Treat, a member of this Board since 1919 and for several years its Vice-President. At its meeting on April 10, 1929, the Board adopted the following minute:

Mr. Charles R. Treat, a member of this Board, died at his home at Orange, Conn., on February 13, 1929, aged 57 years.

Born in Orange, he attended the public school there and later the New Haven High School, entered the Sheffield Scientific School of Yale University and graduated among the leaders of his class in 1894. He then took graduate study in civil and mining engineering at the same institution. The next two years were spent in Nevada in the mining industry. Then the call of the land brought him back to his home and to the development of the farm's resources; a business which he followed till his death. He was a leader in the production of seed sweet corn, successfully applying to it scientific method and experiment, in which he cooperated with this Station. His ability and power of leadership in agricultural affairs were quickly recognized. He was one of the organizers of the New Haven County Farm Bureau and continuously a director of it from 1915 till his death. He was a member of the State Board of Agriculture from 1917 till it was succeeded by a Commissioner. In 1917 and again in 1919 he was a member of the lower house of the General Assembly, in both terms a member of the committee on agriculture and in the second term its chairman. In 1921 he was elected to the Senate and was the chairman of its committee on agriculture. For

15 years he served on the school board of his native town. He also served as town treasurer, vice-president of the Home Bank and Trust Co. of Orange, and as a director of the Federal Land Bank of Springfield, Mass.

In 1919 Mr. Treat was appointed a member of the Board of Control of this Station and served as a member and as one of its executive committee until his death. To these duties he brought a wide acquaintance with agricultural problems and with the farmers of the state, experience in financial and legislative matters, and a clear common sense. He was interested and appreciative both of the research work of the Station and of its practical application to the work of the farm. His opinion and experience were invaluable to his associates, while his frankness, reasonableness and genial comradeship made him a most agreeable companion.

This Board here records their great appreciation of his public services, especially of his wise, helpful and unselfish services to this Station, and their deep sense of personal sorrow and of loss in his departure.

All of which is respectfully submitted,

GEORGE A. HOPSON,

Secretary.

REPORT OF THE TREASURER

July 1, 1928—June 30, 1929

RECEIPTS

Balance on hand, July 1, 1928:			
State Appropriation		....	$72.82
State Appropriation (current expense)		$53,000.00	
" " (miscellaneous additions)		579.15	
United States Appropriation (Hatch)		7,500.00	
" " " (Adams)		7,500.00	
" " " (Purnell)		25,000.00	
" " " (Clarke-McNary)		1,504.21	
Yale Soil Fund		850.00	
Fertilizer analysis fees		13,500.00	
Feed analysis fees		6,800.00	
Lockwood Trust Fund		6,000.00	122,233.36
			$122,306.18
MISCELLANEOUS RECEIPTS:			
Balance on hand, July 1, 1928		$119.23	
Sales of gasoline	$364.27		
Sales of automobile oil	31.22		
Mileage for use of automobiles	268.60		
Sale of waste and old paper	7.07		
Sale of photographic enlargement	5.00		
Interest on bank deposits	112.98	789.14	
		$908.37	
LESS MISCELLANEOUS RECEIPTS DEPOSITED WITH STATE TREASURER		686.61	221.76
			$122,527.94

DISBURSEMENTS

Salaries	$75,237.49
Labor	20,024.91
Stationery and office supplies	1,070.91
Scientific supplies (chemicals)	1,395.51
" " (other laboratory supplies)	1,531.44
" " (photographic supplies)	222.06
Feeding stuffs	310.55
Insecticides, etc.	93.46
Lumber and small hardware	17.12
Miscellaneous supplies	928.43
Automobile oil	248.74
Food and drug samples	7.21
Fertilizers	906 71
Telegraph and telephone	401.25
Postage	435.96
Travel expense (outlying investigations)	1,253.68
" " (meetings, conferences, etc.)	1,527.94
" " (gasoline for automobiles)	977.55

Freight, express and parcel post	$ 230.99	
Miscellaneous transportation charges	59.80	
Publications (reprints, etc.)	279.42	
Coal	1,778.59	
Gas and electricity	2,173.19	
Water	242.65	
Furniture and fixtures (new)	970.25	
" " " (repairs)	84.97	
Library (books and periodicals)	1,046.19	
" (binding)	163.20	
Scientific equipment (new)	997.37	
" " (repairs)	103.92	
Automobiles (new)	490.00	
" (repairs)	385.76	
Tools, machinery and appliances (new)	590.47	
" " " " (repairs)	146.05	
New buildings and structures	3,083.50	
Buildings (repairs and alterations)	1,106.11	
Grounds	1.80	
Insurance (fire, burglary and automobile)	1,198.56	
Miscellaneous contingent expenses	214.00	
Total disbursements		$121,937.71
Balance on hand June 30, 1929:		
State General Appropriation (in hands of State Comptroller)	$368.47	
Miscellaneous receipts (in hands of Station Treasurer)	221.76	590.23
		$122,527.94

William L. Slate,

Treasurer.

REPORT OF

WILLIAM L. SLATE, TREASURER

IN ACCOUNT WITH

FOOD AND DRUG APPROPRIATION

July 1, 1928—June 30, 1929

RECEIPTS

State Comptroller (Food and Drug Appropriation)	$7,500.00

EXPENDITURES

Salaries	$7,500.00

REPORT OF

WILLIAM L. SLATE, TREASURER

IN ACCOUNT WITH

INSECT PEST APPROPRIATION

(Section 2109 of General Statutes, Revision of 1918)

July 1, 1928—June 30, 1929

RECEIPTS

Insect Pest Appropriation	$30,000.00		
Deficiency appropriation	15,000.00		
Refunds, etc.	543.32		
		$45,543.32	
Charged to allotment for second year of fiscal period, July 1, 1928		8,888.05	
			$36,655.27

DISBURSEMENTS

Salaries	$18,710.00		
Labor	7,936.43		
Stationery and office supplies	175.64		
Scientific supplies (chemicals)	22.94		
" " (other laboratory supplies	22.58		
" " (photographic supplies)	95.11		
Insecticides, etc.	804.11		
Lumber and small hardware	3.40		
Miscellaneous supplies	110.46		
Automobile oil	144.53		
Fertilizer	10.00		
Telegraph and telephone	188.02		
Postage	71.50		
Travel expense (outlying investigations)	2,759.29		
" " (meetings, etc.)	364.14		
" " (gasoline for automobiles)	731.44		
Freight, express and parcel post	38.98		
Electricity	39.24		
Furniture and fixtures (new)	491.19		
" " " (repairs)	23.45		
Library (books and periodicals)	89.44		
Scientific equipment (new)	570.39		
" " (repairs)	1.35		
Automobiles (new)	581.00		
" (repairs)	339.99		
Tools, machinery and appliances (new)	145.49		
" " " " (repairs)	2.25		
New buildings and structures	709.69		
Buildings (repairs and alterations)	15.15		
Rent of land and buildings	58.75		
Insurance, automobile	54.92		
Miscellaneous contingent expenses	131.84		
Total disbursements		$35,442.71	
Balance on hand, June 30, 1929		1,212.56	
			$36,655.27

REPORT OF

WILLIAM L. SLATE, DIRECTOR

IN ACCOUNT WITH

MOSQUITO ELIMINATION APPROPRIATION

(Sections 2409 and 2410 of General Statutes, Revision of 1918; Amended by Chapter 68, Public Acts of 1923)

July 1, 1928—June 30, 1929

RECEIPTS

State Appropriation	$7,500.00		
Deficiency Appropriation	7,446.00		
Sale of tools and use of automobile	60.05		
		$15,006.05	
Charged to allotment for second year of fiscal period, July 1, 1928		777.40	
			$14,228.65

DISBURSEMENTS

Salary	$2,500.00	
Labor	9,734.78	
Stationery and office supplies	52.85	
Photographic supplies	4.40	
Miscellaneous supplies	57.90	
Automobile oil	7.50	
Telephone and telegraph	8.55	
Travel (outlying investigations)	435.04	
" (meetings and conferences)	41.28	
" (gasoline)	197.28	
Freight, express and parcel post	7.87	
Furniture and fixtures (new)	4.95	
Scientific equipment (new)	19.48	
Tools, machinery and appliances (new)	210.54	
" " " " (repairs)	17.92	
Automobile repairs and accessories	*297.06*	
Tidegates and culverts	69.60	
" " " (repairs)	103.47	
Insurance (automobile)	49.49	
		$13,819.96
Balance on hand, June 30, 1929		408.69
		$14,228.65

REPORT OF

WILLIAM L. SLATE, DIRECTOR

IN ACCOUNT WITH

TOBACCO RESEARCH APPROPRIATIO]

(Public Acts, 1921, Chapter 184)

July 1, 1928—June 30, 1929

RECEIPTS

State Appropriation	$15,000.00		
Sales of tobacco	1,881.24		
Insurance rebate	12.50		
		$16,893.74	
Charged to allotment for second year of fiscal period, July 1, 1928		663.11	
			$16,230.63

DISBURSEMENTS

Salaries	$9,860.00	
Labor	2,054.18	
Stationery and office supplies	68.81	
Chemicals	18.98	
Laboratory supplies	33.35	
Photographic supplies	37.18	
Feeding stuffs	19.50	
Insecticides and fungicides	12.20	
Lumber and small hardware	67.33	
Miscellaneous supplies	580.27	
Automobile oil	17.00	
Fertilizer	682.19	
Telephone, telegraph and telegram	59.49	
Travel (outlying investigations)	378.74	
" (meetings, conferences, etc.)	102.71	
" (gasoline)	82.40	
Freight, cartage and express	125 08	
Coal	673.65	
Printing	2.15	
Electricity	85.44	
Water	32.57	
Furniture and fixtures (repairs)	13.35	
Books, periodicals and subscriptions	26.50	
Library (binding)	6.75	
Scientific apparatus (new)	229.93	
Automobiles (new)	548.00	
Automobiles (repairs)	12.30	
Tools, machinery and appliances (new)	133 91	
" " " " (repairs)	13.06	
Buildings (repairs and alterations)	76.56	
Rent of land	75.00	
Buildings and land (grounds)	35.68	
Insurance (automobile and tobacco)	57.28	
Contingent	2.60	
		$16,224.14
Balance on hand, June 30, 1929		6.49
		$16,230.63

REPORT OF

WILLIAM L. SLATE, DIRECTOR

IN ACCOUNT WITH

WHITE PINE BLISTER RUST APPROPRIATION

(Section 2117 of General Statutes, Revision of 1918)

July 1, 1928—June 30, 1929

RECEIPTS

State Appropriation	$7,500.00		
Refund for labor	2,863.08		
		$10,363.08	
Charged to allotment for second year of fiscal period, July 1, 1928		2,548.92	
			$7,814.16

EXPENDITURES

By the State Comptroller on vouchers submitted by William L. Slate, *Director*			
Salaries	$600.00		
Labor	6,383.03		
Lumber and small hardware	31.18		
Miscellaneous supplies	4.85		
Telegraph and telephone	25.36		
Travel (outlying investigations)	366.54		
" (meetings, conferences, etc.)	27.30		
Automobiles (repairs)	65.65		
Insurance (automobile)	153.46		
Miscellaneous contingent expenses	155.79		
Total disbursements		$7,813.16	
Balance on hand, June 30, 1929		1.00	
			$7,814.16

BULLETIN 308 SEPTEMBER, 1929

Connecticut Agricultural Experiment Station

New Haven

REPORT ON INSPECTION

OF

COMMERCIAL FERTILIZERS FOR 1929

E. M. BAILEY, *Chemist in Charge of the Analytical Laboratory.*

CONTENTS.

	Page
The Fertilizer Law	3
Definitions and Standards for Some Fertilizer Materials	7
Registrations	10
Inspection of 1929	21
Raw Materials Containing Nitrogen	22
Raw Materials Containing Phosphoric Acid	39
Raw Materials Containing Potash	44
Raw Materials Containing Nitrogen and Potash	54
Raw Materials Containing Nitrogen and Phosphoric Acid	56
Mixed Fertilizers:	
Containing Nitrogen and Phosphoric Acid	66
Containing Phosphoric Acid and Potash	66
Containing Nitrogen and Potash	66
Containing Nitrogen, Phosphoric Acid and Potash	67
Special Mixtures and Home Mixtures	93
Miscellaneous Fertilizers, Amendments, etc.:	
Sheep Manure, etc.	93
Lime, etc.	93
Other miscellaneous	93
Collaborative Work	93
Chlorine in Some Fertilizer Materials	106
Index	i

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

BOARD OF CONTROL

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THE TUTTLE, MOREHOUSE & TAYLOR COMPANY, NEW HAVEN, CONN.

INSPECTION OF COMMERCIAL FERTILIZERS 1929

E. M. Bailey,*
Chemist in Charge, Analytical Laboratory.

THE FERTILIZER LAW.

The provisions of the Connecticut fertilizer law have been discussed in previous reports but for more ready reference its essential features may be mentioned here.

Significance of the Term "Commercial Fertilizers."

Explaining what is meant by the term "commercial fertilizers" the law says:

"The term 'commercial fertilizers' shall be construed to mean any and every substance imported, manufactured, prepared or sold for fertilizing or manuring or soil amendment purposes, except barnyard manure and stable manure which have not been artificially treated or manipulated, marl and lime. Cottonseed meal, rapeseed meal, castor pomace and all other vegetable products used as fertilizers, including the ashes of cotton hulls and wood ashes, shall be included as fertilizers within the meaning of this act and separate analysis fees shall be paid on each different grade which is sold or offered for sale in the state. The person responsible for paying the fees above prescribed may deduct from the total tonnage sold such sales of cottonseed meal or other vegetable products as are made to anyone who gives a written certificate on a form supplied by the Connecticut Agricultural Experiment Station stating that the material bought by him was to be used exclusively for feed and not for fertilizer."

Concerning Cottonseed Meal.

Cottonseed meal is a fertilizer within the meaning of the Statute but it is provided that when this product is sold for feeding purposes only, it shall be exempt from the tonnage tax. When sold as a feed, cottonseed meal is subject to registration under the terms of the feed law. By regulation, however, if it is sold exclusively as a fertilizer, or exclusively as a feed, it may be registered but once, and under that law which applies.

The status of cottonseed meal under the fertilizer law has been clearly stated in a bulletin[1] from this Station, from which the following may be quoted:

---

* Analyses were made by Messrs. Nolan, Mathis and Walden; microscopic examinations by Mr. Shepard and Miss Yale; inspection and sampling by Mr. Churchill; and the compilations largely by Mrs. Vosburgh.

[1] Bull. of Information No. 9, 1919.

Registration and analysis fees. "Each brand of cottonseed meal must be registered on forms provided by this Station and an analysis fee of ten dollars paid on it before it is sold, offered or exposed for sale, and on the first day of January annually thereafter."

"A distinctive name constitutes a distinct brand. If shipments have different guaranties of composition they are held to be different brands."

Branding or tagging. "Since nitrogen is the only fertilizer ingredient considered in the trade in cottonseed meal, no guaranty of phosphoric acid or potash is required. If either is guaranteed by the manufacturer, however, an additional fee of ten dollars must be paid on each element. The statement of composition now legal for feeds may be used hereafter if the percentage of nitrogen is stated."

"Note that the law regarding feeding stuffs forbids the use of metal in attaching tags and requires that each package shall be branded or tagged with the statement required by law."

Duties of shippers. "It is assumed from correspondence with shippers outside the state that they will register the brands which they sell in Connecticut, will pay analysis fees as has been done in the past by manufacturers of commercial fertilizers, and will semi-annually thereafter pay the tonnage fees.

"They will report to this Station their total sales and if they wish, may report what part has been sold for feed exclusively. From the reports of dealers within the state it will be possible to determine quite closely the amounts of each brand actually used as feed.

"In the case the jobber outside the state neglects or refuses to register a brand, the dealer who sells it within the state is responsible under the law."

Duties of dealers. "Dealers are required to file with the director of the Station on July first of each year and semi-annually thereafter a sworn statement of their total sales of each brand of cottonseed meal and the amount of each sold exclusively for feed, during the preceding six months."

Requirements to be Complied with by Sellers of Commercial Fertilizers.

The seller is responsible for the proper labeling of each package, for the registration at the Station of every brand sold by him and for the payment of the analysis fee, before offering for sale, and annually thereafter on January 1st.

The law specifies the information which shall be given on the label as follows:

1. *Weight of each package in pounds.*
2. *Brand name or trade mark.*
3. *Analysis:*
    - (a) *Available phosphoric acid, per cent.*
    - (b) *Total phosphoric acid, per cent.*
    - (c) *Nitrogen, per cent.*
    - (d) *Equivalent ammonia, per cent.*
    - (e) *Potash soluble in water, per cent.*

4. *Name and address of the manufacturer or of the person who is responsible for the statement of the guaranty.*

In the case of bone meal, tankage or other organic products, and in basic slag and mineral phosphates in which a large percentage of the phosphoric acid is not available by laboratory methods, the phosphoric acid shall be claimed as total phosphoric acid unless it is desired to claim available phosphoric acid instead, in which case the guaranty shall take the form set forth above.

The label may be a tag attached to the package or a statement printed thereon. Percentages shall be minimum percentages only.

The presence of leather in its various forms, wool waste, hair, or any inert nitrogenous material shall be declared on the label unless, by processing, the activity of these materials has been rendered satisfactory as determined by official methods.

When potash is derived from sulphate or carbonate of potash it may be so claimed.

No claim or guaranty for less than 0.82 per cent of nitrogen or for less than 1 per cent of phosphoric acid, or for less than 1 per cent of potash shall be regarded in the registration or analysis of any commercial fertilizer.

The seller must also, on the 1st of January and July, report the tonnage of fertilizer sold within the preceding six months and pay to the director of the Station a tonnage fee of 6 cents per ton. On request, copies of the law and blanks for registration and for tonnage reports will be supplied by the Station.

If, however, proper labeling, registration and payments have been provided for by the manufacturer of the brands or by another responsible person all sellers of such brands are released from the above mentioned requirements. The retailer, therefore, should assure himself that the requirements of the law have been met by the manufacturers of the brands which he handles, or himself be prepared to meet all these requirements.

Precautions to be Observed in Drawing Samples for Analysis.

The analysis of a fertilizer is of no value unless the sample analyzed represents as nearly as possible the stock from which the sample was drawn. The law prescribes the procedure to be followed by authorized agents of this Station when taking official samples for analysis as follows:

"When samples are taken from fertilizers in bags, a tube shall be used, and it shall be inserted at one end of the bag and shall pass substantially the entire length of the bag, so as to take a core of the material being sampled from substantially the entire length of the bag. Samples thus taken from individual bags shall be thoroughly mixed, and the official samples shall be taken from the mixture so drawn by the method known as 'quartering.' Samples of fertilizers taken as herein provided shall be taken from at least five per centum of the separate original unopened

packages in the lot, for the mixture from which the official samples shall be taken. If less than one hundred bags are in the lot, at least five bags shall be sampled; if less than five bags, all shall be sampled. Broken packages shall not be sampled."

Gratuitous Analyses.

Under the fertilizer law the Station is charged only with the analysis of samples drawn by its own agents. It does, however, each year analyze a considerable number of samples drawn by individuals, representing stock purchased by them for their own use. The object of the purchaser is to satisfy himself as to whether he has obtained goods of the grade represented and, perhaps, to obtain evidence upon which to base a claim for shortage should the materials not meet their guaranties. The Station assumes no responsibility for the sampling in case of such unofficial samples and can only vouch for the accuracy of the results obtained on the materials as submitted. Since a representative sample is as essential as an accurate analysis in judging the quality of a shipment of fertilizer, it is evident that a satisfactory adjustment will seldom be effected on the basis of an unofficial sample. Notwithstanding certain objections which may be raised to the practice of analyzing samples submitted by individuals, the Station is disposed to continue such work so long as there is evidence that it constitutes a useful service.

DEFINITIONS AND STANDARDS FOR SOME FERTILIZER MATERIALS.

The Association of Official Agricultural Chemists upon the recommendation of its Committee on Definition of Terms and Interpretation of Results on Fertilizers has approved for final adoption as official, definitions and standards for the following materials:

1. *Limit of chlorine in mixed fertilizers in which potash is claimed as sulphate.* The chlorine in mixed fertilizers in which the potash is claimed as sulphate shall not exceed five-tenths of one per cent (0.5%) more than what is called for in the minimum potash content based on the definition for sulphate of potash as formulated by the committee. Calculate as follows: 0.05 times the percentage of potash found plus 0.5.

2. *Products obtained by heating calcium phosphate with alkali salts containing potash.* These products are *not* potassium phosphate. They may be called non-acid phosphates with potash.

3. *Muriate of potash.* For further consideration.

4. *Sulphate of potash.* Definition was proposed but not approved. For further consideration.

5. *Unleached wood ashes.* Unleached wood ashes are ashes that result from burning unleached wood, that have had no part of their plant food removed, and that contain four per cent (4%) or more of water-soluble potash (K_2O).

6. *Nitrate of Soda.* Nitrate of soda is commercial sodium nitrate containing not less than fifteen per cent (15%) of nitrogen, chiefly as sodium nitrate.

7. *Kainit.* Kainit is a potash salt containing potassium and sodium chlorides and sometimes sulphate of magnesia with not less than twelve per cent (12%) of potash (K_2O).

8. *Dried Blood.* Dried blood is the collected blood of slaughtered animals, dried and ground and containing not less than twelve per cent (12%) of nitrogen in organic forms.

9. *Fertilizer grade.* The grade of fertilizer shall represent the minimum guarantee of its plant food expressed in terms of nitrogen, available phosphoric acid, and water-soluble potash.

The following definitions have also been approved as tentative.

1. *Ground steamed bone.* Ground steamed bone is a product resulting from grinding animal bones that have been previously steamed under pressure.

2. *Ground raw bone.* Ground raw bone is a product resulting from drying and grinding animal bones that have not been previously steamed under pressure.

3. *Tankage.* This term (without qualification) shall be restricted to meat and bone tankage derived from the rendered, dried, and ground by-products from the slaughter of animals, or from carcasses of animals that have died otherwise than by slaughter.

4. *Fish tankage, fish scrap, dry ground fish.* Fish tankage, fish scrap, dry ground fish is the dried ground product derived from rendered or unrendered fish.

5. *Garbage tankage.* Garbage tankage is the rendered, dried, and ground product derived from waste household food materials.

6. *Crude, inert, or slow-acting nitrogenous materials.* Crude, inert, or slow-acting nitrogenous materials are unprocessed organic substances relatively high in nitrogen but having a very low value as plant food and showing a low activity by both the alkaline and neutral permanganate methods (below fifty per cent (50%) and eighty per cent (80%), respectively).

7. *Process tankage.* Process tankages are the products made from crude inert nitrogenous materials by processing under steam pressure, with or without the use of acids, for the purpose of increasing the activity of the nitrogen.

These products shall not be called "tankages" without proper qualification.

8. *Hoof and Horn Meal.* Hoof and horn meal is a product resulting from the processing, drying and grinding of hoofs and horns.

9. *Superphosphate.* Superphosphate is the ground product resulting from mixing finely ground rock phosphate and sulfuric acid or phosphoric acid. The grade should always be used as a prefix to the name. Example: 16% Superphosphate.

It is recommended that the use of the term "Acid Phosphate" be discontinued.

10. *Order of terms.* The order of terms in mixed fertilizers shall be nitrogen first, phosphoric acid second, and potash third.

11. *Statement of guaranties.* It is recommended and urged that the statement of guaranties of mixed fertilizers be given in whole numbers and without fractions.

12. *Acidulated fish tankage, fish scrap, dry ground fish.* Acidulated fish tankage, fish scrap, dry ground fish is the rendered, dried, and ground product derived from fish and with or without treatment with sulfuric acid.

13. *Significance of the name of a fertilizer material used as a brand name of a mixed fertilizer.* When the name of a material is used as a part of the brand name of a mixed fertilizer, as for example blood, or fish, the nitrogen or phosphoric acid shall be derived from or supplied entirely by the material named. When

the name of a material is used as a brand or as part of a brand the word "brand" shall follow the name of the material. Example: "Fish Brand Fertilizer."

14. *Ammoniated superphosphate.* Ammoniated superphosphate is that class of product containing both dissolved phosphate (superphosphate or dissolved bone) and nitrogenous compounds, but without the addition of potash.

15. *Activated sewerage products.* Activated sewerage products are made from sewage freed from grit and coarse solids and aerated after being inoculated with micro-organisms. The resulting flocculated organic matter is withdrawn from the tanks, filtered with or without the aid of coagulants, dried in rotary kilns, ground, and screened.

Other fertilizer materials and soil amendments under consideration by the Committee are: agricultural lime, quicklime, hydrated lime, air-slaked lime, ground limestone, ground shell lime, marl, by-product lime, calcium sulphate, available phosphoric acid, high-analysis fertilizer, soil amendment, peat, charred peat, sulphate of ammonia, urea, and cyanamide.

REGISTRATIONS.

LATE REGISTRATIONS FOR 1928.

To the brands registered for 1928 in our last report should be added:

L. B. Lovitt & Company, Memphis, Tenn.

"Lovit Brand" 36% Cottonseed Meal
"Lovit Brand" 41% Cottonseed Meal

Memphis Cottonseed Products Company, Memphis, Tenn.

Durham Brand 41% Protein Cottonseed Meal

REGISTRATIONS FOR 1929.

For 1929, 67 firms and individuals registered at this Station for sale in this State 422 brands of fertilizers. As required by Statute the brands so registered are listed as follows:

American Agricultural Chemical Company, New Haven Sales Dept., New Haven, Conn.

A.A.C. Acme Fertilizer
A.A.C. Aroostook Potato Manure
A.A.C. Castor Pomace
A.A.C. Complete General Fertilizer
A.A.C. Cotton Seed Meal
A.A.C. Double A Tobacco Fertilizer
A.A.C. Dry Ground Fish
A.A.C. Gladiator Fertilizer
A.A.C. Grass & Lawn Top Dressing
A.A.C. Ground Tankage
A.A.C. Hi-Grade Tobacco Manure
A.A.C. Monarch Fertilizer
A.A.C. Muriate of Potash
A.A.C. Nitrate of Soda
A.A.C. Pulverized Sheep & Goat Manure
A.A.C. Prolific 10% Potash Fertilizer
A.A.C. Special Grass Top Dressing
A.A.C. Special Ground Bone
A.A.C. Sulphate of Ammonia
A.A.C. Sulphate of Potash
A.A.C. 16% Superphosphate
A.A.C. Tobacco Starter
Agrico for Corn
Agrico for Potatoes
Agrico for Truck
Bowker's All Round Fertilizer
Bowker's Market Garden Fertilizer
Bowker's Potato & Vegetable Phosphate
Bowker's Stockbridge Early Crop Manure
Bowker's Stockbridge Hill & Drill Fertilizer
Bowker's Stockbridge Tobacco Manure
Bradley's Blood, Bone & Potash
Bradley's Complete Manure for Potatoes & Vegetables
Bradley's Complete Tobacco Manure
Bradley's Northland Potato Grower

Bradley's Potato Fertilizer
Bradley's Potato Manure
Bradley's XL Superphosphate of Lime
National Aroostook Special Fertilizer
National Complete Tobacco Fertilizer
National Market Garden Fertilizer
National Pine Tree State Potato Fertilizer
National Premier Potato Manure
Sanderson's Atlantic Coast Mixture
Sanderson's Complete Tobacco Grower
Sanderson's Corn Superphosphate
Sanderson's Formula A
Sanderson's Formula B
Sanderson's Potato Manure

American Cyanamid Company, 535 Fifth Ave., New York City.

Aero Brand Cyanamid
Ammo Phos B
Ammo-Phos-Ko No. 1
Ammo-Phos-Ko No. 2
Ammo-Phos-Ko No. 3

Anglo-Chilean Nitrate Sales Corporation, 120 Broadway, New York City.

Nitrate of Soda

Apothecaries Hall Company, Waterbury, Conn.

Acid Phosphate (Superphosphate)
Basic Slag Phosphate
Bone Meal 3-22
Bone Meal 4-20
Bone & Meat Tankage
Carbonate of Potash
Castor Pomace
Cotton Seed Meal
Dry Ground Fish
Lawn Fertilizer
Liberty Corn & All Crops 2-8-2
Liberty Corn, Fruit & All Crops, 2-12-4
Liberty Double Strength, 10-16-14
Liberty Fish, Bone & Potash, 3-8-3
Liberty High Grade Market Gardener's, 5-8-7
Liberty High Grade Tobacco Manure, 7-3-7
Liberty Onion Special (Potash as Sulphate) 4-8-7
Liberty Potato & General Crops, 4-8-10
Liberty Potato & Market Gardener's Special, 4-8-4
Liberty Potato & Vegetable, 2-8-10
Liberty Special Fertilizer for Fruit, 7-8-6
Liberty Tobacco Special (Cotton Seed Meal Base), 5-3-5
Liberty Top Dresser for Grass & Grain, 10-3½-8
Muriate of Potash
Nitrate of Soda
Nitrate of Soda & Potash
Precipitated Bone
Sulphate of Ammonia
Sulphate of Potash
Sulphate of Potash & Magnesia
Tankage

Armour Fertilizer Works, 50 Broad St., New York City.

Armour Big Crop Bone Meal 3-48
Armour Big Crop Fertilizer 2-12-4
Armour Big Crop Fertilizer 3-8-4
Armour Big Crop Fertilizer 4-6-10
Armour Big Crop Fertilizer 4-8-4
Armour Big Crop Fertilizer 4-8-7
Armour Big Crop Fertilizer 4-16-4
Armour Big Crop Fertilizer 5-8-7
Armour Big Crop Fertilizer 5-15-5
Armour Big Crop Fertilizer 7-11-10
Armour Big Crop Fertilizer 7-12-7
Armour Big Crop Fertilizer 8-6-6
Armour Big Crop Tobacco Fertilizer 7-3-7
Armour Big Crop Tobacco Special 5-3-5
Armour Big Crop Super Phosphate 16%
Armour Big Crop Super Phosphate 20%
Armour Lawn & Garden Grower 6-8-6
Castor Pomace
Cotton Seed Meal
Ground Tankage
Muriate of Potash
Nitrate of Soda
NPK 9-18-18
NPK 9-27-9
Sheep & Goat Manure
Sulphate of Ammonia
Sulphate of Potash

Ashcraft-Wilkinson Company, Atlanta, Ga.

Helmet Brand Cottonseed Meal
Monarch Brand Cottonseed Meal
Paramount Brand Cottonseed Meal

Associated Seed Growers, Inc., New Haven, Conn.

Nitrate of Soda
16% Acid Phosphate
Special Mixture for General Use
Special Mixture with 6% Potash
Tip Top Brand

Baker Castor Oil Company, 120 Broadway, New York City.

Castor Pomace

Barrett Company, 40 Rector St., New York City.

Arcadian Nitrate of Soda
Arcadian Sulphate of Ammonia
Sulphate of Ammonia

F. A. Bartlett Tree Expert Company, Stamford, Conn.

Bartlett Green Tree Food

The Berkshire Chemical Company, Bridgeport, Conn.

Berkshire Castor Pomace
Berkshire Complete Fertilizer
Berkshire Complete Tobacco Fertilizer
Berkshire Dry Ground Fish

Berkshire Economical Grass Fertilizer
Berkshire Fine Ground Bone
Berkshire Grass Special Fertilizer
Berkshire Long Island Special Fertilizer
Berkshire Market Garden Fertilizer
Berkshire Sheep Manure
Berkshire Super Phosphate
Berkshire Tobacco Special Fertilizer
Berkshire Tobacco Starter Fertilizer
Berkshire Truck Fertilizer
High Grade Sulphate Potash
Muriate of Potash
Nitrate of Soda

Amos D. Bridge's Sons, Inc., Hazardville, Conn.

Corn, Onion, Potato and General Purpose
Special Tobacco Fertilizer

F. W. Brode Corporation, Memphis, Tenn.

Owl Brand 41% Prime Cottonseed Meal

A. H. Case & Company, Inc., 965 William St., Buffalo, N. Y.

Par Plus Brand Reinforced Sheep Manure

The E. D. Chittenden Company, Bridgeport, Conn.

Castor Pomace
Chittenden's Complete Tobacco & Onion Grower
Chittenden's High Grade Potato
Chittenden's Potato Special
Chittenden's Tobacco Special

Conn. Fat Rendering & Fertilizer Corporation, West Haven, Conn.

Tankage

Consolidated By-Product Company, 30th and Race Sts., Philadelphia, Pa.

Consolidated Bone Meal

Consolidated Rendering Company, Boston, Mass.

Castor Pomace
Corenco Sheep Manure
Dry Ground Fish
Ground Bone
Muriate of Potash
Nitrate of Soda
Sulphate of Ammonia
Snlphate of Potash
Superphosphate (Acid Phos. 16%)
Superphosphate (Acid Phos. 20%)
Tankage 6-30
Tankage 9-20

C & R Sales Company, Worcester, Mass.

C & R Lawn Shrub Fertilizer 5-6-5

Davey Tree Expert Company, So. Water St., Kent, Ohio.

Davey Shredded Cattle Manure
Davey Tree Food

Eastern States Farmers' Exchange, Springfield, Mass.

Eastern States Ammo-Phos
Eastern States Basic Slag
Eastern States Calurea
Eastern States Castor Pomace
Eastern States Dry Ground Fish
Eastern States Fine Bone Meal
Eastern States Ground Animal Tankage
Eastern States Muriate of Potash
Eastern States Nitrate of Potash
Eastern States Nitrate of Soda
Eastern States Nitrogenous Tankage
Eastern States Open Formula 0-14-6
Eastern States Open Formula 4-8-8
Eastern States Open Formula 4-10-6
Eastern States Open Formula 4-12-4
Eastern States Open Formula 4-20-16
Eastern States Open Formula 6-8-6
Eastern States Open Formula 6-15-9
Eastern States Open Formula 6-18-6
Eastern States Open Formula 8-4-8
Eastern States Open Formula 8-16-16
Eastern States Open Formula 8-16-16 Potash from Sulpha
Eastern States Open Formula 10-5-10
Eastern States Precipitated Bone
Eastern States Sulphate of Ammonia
Eastern States Sulphate of Potash
Eastern States Sulphate of Potash Magnesia
Eastern States Superphosphate 16%

Ed. Eggert, Hartford, Conn.

Diamond "EE" Brand Cottonseed Hull Ashes

Essex Fertilizer Company, Boston, Mass.

Essex Complete Manure 5-8-7
Essex Fish Fertilizer for All Crops 3-8-4
Essex Market Garden 4-8-4
Essex Peerless Potato Manure 4-6-10
Essex Top Dressing 7-6-5

Friedman Tobacco Products Corporation, 240 No. George St., York, Pa.

Double Duty Tobacco Dust Fertilizer

The L. T. Frisbie Company, New Haven, Conn.

Frisbie's Corn & Grain Fertilizer 2-10-2
Frisbie's Fine Bone Meal
Frisbie's 5-8-7
Frisbie's 5-10-5
Frisbie's Market Garden 5-8-7
Frisbie's Special 3-8-4
Frisbie's Special Vegetable & Potato Grower 4-8-4
Frisbie's Tobacco Grower 7-3-7
Frisbie's Top Dresser 8-6-5

Ford Motor Company, Fordson, Michigan.
Ford Ammonium Sulphate

The Grasselli Chemical Company, Cleveland, Ohio.
Grasselli Odorless Plant Food

Humphreys-Godwin Company, Memphis, Tenn.
Bull Brand Cottonseed Meal
Danish Brand Cottonseed Feed
Dixie Brand Cottonseed Meal

International Agricultural Corporation, 38 Chauncy St., Boston, Mass.
Caribee Tobacco Fertilizer
Premium Tobacco Fertilizer

John Joynt, Lucknow, Ontario, Canada.
Joynt Brand "Canada Hardwood Ashes"

Kelloggs & Miller, Inc., Amsterdam, N. Y.
"K & M" Brand Pure Old Process Linseed Oil Meal

Spencer Kellogg & Sons, Inc., Buffalo, N. Y.
Castor Pomace
"Kellogg's Pure Old Process Linseed Meal" 5.14%
"Kellogg's Pure Old Process Linseed Meal" 6.22%

L. B. Lovitt & Company, Memphis, Tenn.
"Lovit Brand" 41% Cottonseed Meal

Lowell Fertilizer Company, Boston, Mass.
Lowell Animal Brand A High Grade Manure for All Crops 3-8-4
Lowell Bone Fertilizer 2-10-2
Lowell Corn and Vegetable 4-8-4
Lowell Market Garden Manure 5-8-7
Lowell Potato Grower 4-6-10
Lowell Tobacco Manure 5-3-5
Lowell Top Dressing 7-6-5

Maine Farmers' Exchange, 801 Chapman Bldg., Portland, Me.
M.F.E. "Produce-More" 3-10-3
M.F.E. "Produce-More" 4-8-5
M.F.E. "Produce-More" 5-8-7

The Mapes Formula & Peruvian Guano Co., 270 Madison Ave., New York City.
The Mapes Connecticut Valley Special
The Mapes Corn Manure
The Mapes General Tobacco Manure
The Mapes General Truck Manure
The Mapes General Use Manure
The Mapes Onion Manure
The Mapes Potato Manure
The Mapes Special Trucker

The Mapes Special Trucker "SP."
The Mapes Tobacco Ash Constituents
The Mapes Tobacco Ash & Starter
The Mapes Tobacco Manure, Wrapper Brand
The Mapes Tobacco Starter Improved
The Mapes Top Dressing
Castor Pomace
Nitrate of Soda
Pure Fine Ground Bone
Sulphate of Potash

Marianna Sales Company, Memphis, Tenn.
White Mule Brand Cotton Seed Meal

A. G. Markham & Company, 20 Stockbridge St., Springfield, Mass.
4-6-10
4-8-4
5-8-7

Millane Tree Expert Company, Cromwell, Conn.
Millane Shade Tree Food

Natural Guano Company, Aurora, Ill.
"Sheep's Head" Pulverized Sheep Manure

New England Fertilizer Company, Boston, Mass.
New England Complete Manure 4-6-10
New England Corn Phosphate 2-10-2
New England Market Garden Manure 5-8-7
New England Potato and Vegetable Manure 4-8-4
New England Super A High Grade Fertilizer For All Crops 3-8-4
New England Tobacco Manure 5-3-5

Old Deerfield Fertilizer Company, Inc., South Deerfield, Mass.
Old Deerfield Tobacco Starter, Bone & Potash
Special Tobacco Formula

Olds & Whipple, Inc., Hartford, Conn.
High Grade Carbonate of Potash 96/98
High Grade Sulphate of Potash
O. & W. Acid Phosphate
O. & W. Blue Label Tobacco Fertilizer
O. & W. Castor Pomace
O. & W. Complete Market Garden Fertilizer
O. & W. Complete Tobacco Fertilizer
O. & W. Dry Ground Fish
O. & W. Favorite Sheep Manure
O. & W. Grass Fertilizer
O. & W. High Grade Potato & Vegetable Fertilizer
O. & W. High Grade Starter & Potash Compound
O. & W. High Grade Tobacco Starter
O. & W. Nitrate of Soda
O. & W. Nitrate of Potash 95%
O. & W. Precipitated Bone Meal
O. & W. Pure Bone Meal
O. & W. Sulphate of Ammonia

Pacific Manure & Fertilizer Company, 429 Davis St., San Francisco, Cal.
Groz-It Pulverized Sheep Manure

Parmenter & Polsey Fertilizer Company, Boston, Mass.
"P & P" Maine Potato Fertilizer 4-6-10
Parmenter & Polsey Top Dressing 7-6-5

Piedmont-Mt. Airy Guano Company, Inc., Baltimore, Md.
Harvest Brand 2-8-3
Harvest Brand 4-8-4
Harvest Brand 5-8-7
Nitrate of Soda

Frank S. Platt Company, New Haven, Conn.
Platt's Concentrated Lawn Fertilizer
Platco Special 5-8-7

Premier Poultry Manure Company, 3-8 W. Washington St., Chicago, Ill.
Premier Brand Poultry Manure
Premier Brand Sheep Manure

Pulverized Manure Company, Chicago, Ill.
Wizard Brand Cattle Manure
Wizard Brand Pulverized Sheep Manure

Rackliffe Bros. Company, Inc., New Britain, Conn.
Rackliffe Brand Corn Fertilizer 4-8-4
Rackliffe Brand Potato and Special Vegetable 5-8-7

The Rogers & Hubbard Company, Portland, Conn.
4-8-4 Fertilizer
5-8-7 Fertilizer
5-10-15 Fertilizer
Hubbard's "Bone Base" Fertilizer for Seeding Down
Hubbard's "Bone Base" Oats and Top Dressing
Hubbard's "Bone Base" Soluble Corn and General Crops Manure
Hubbard's "Bone Base" Soluble Potato Manure
Hubbard's "Bone Base" Soluble Tobacco Manure
Hubbard's Pure Raw Knuckle Bone Flour
Hubbard's Strictly Pure Fine Bone
Lawn Fertilizer
Nitrate of Soda
Rogers & Hubbard's All Soils-All Crops Fertilizer
Rogers & Hubbard's Climax Tobacco Brand
Rogers & Hubbard's Corn and Grain Fertilizer
Rogers & Hubbard's High Potash Fertilizer
Rogers & Hubbard's Potato Fertilizer
Rogers & Hubbard's Tobacco Grower, Vegetable Formula
Rogers & Hubbard's Tunaker Tobacco Brand
Superphosphate

F. S. Royster Guano Company, Baltimore, Md.
Royster's Connecticut Tobacco Guano
Royster's Curlew Guano
Royster's 5% Truck Guano

Royster's Gem Guano
Royster's Quality Trucker
Royster's Sheep and Goat Manure
Royster's 16% Super Phosphate
Royster's Top Dresser

Ruhm Phosphate & Chemical Company, Mt. Pleasant, Tenn.
Ruhm's Lime Phosphate (*Phosphate Rock*, washed and ground)

Sewerage Commission of the City of Milwaukee, Milwaukee, Wis.
Milorganite

M. L. Shoemaker & Company, Inc., Philadelphia, Pa.
Special Mixture of "Bantle's Wrapper Brand"
"Swift-Sure" Bone Meal 4½-47
"Swift-Sure" Potato Special 5-8-7
"Swift-Sure" Special Tobacco Formula 4-8-5
"Swift-Sure" Tobacco & General Use 3-10-3

Springfield Rendering Company, Springfield, Mass.
Springfield 3-8-4 Fertilizer
Springfield 4-8-4 Fertilizer
Springfield 4-8-7 Fertilizer
Springfield 5-8-7 Fertilizer
Springfield 5-3-5 Tobacco Special
Springfield 7-6-5 Top Dresser

Standard Wholesale Phosphate & Acid Works, Inc., Baltimore, Md.
5 x 4 x 5
5 x 10 x5
8 x 6 x 6
Animal Tankage 6%
Animal Tankage 9%
Animal Tankage 10%
Castor Pomace
Evergreen Fish Guano
Fish Bone & Potash
Fish Meal
Golden Rule Grower
Golden Rule Guano
Grain Grower
High Analysis
Ideal Potato Grower
Jersey Special
Mammoth Potato Grower
Muriate of Potash
Nitrate of Soda
Old Fertility
Raw Bone Meal
Steamed Bone Meal
Sulphate of Ammonia
Sulphate of Potash
Superphosphate 16%
Superphosphate 20%
Truckers Fish Guano

Swift & Company Fertilizer Works, Baltimore, Md.

Vigoro

Synthetic Nitrogen Products Corporation, 285 Madison Ave., New York City.

Calcium Nitrate Basf (Nitrate of Lime)
Calurea
Nitrophoska I
Nitrate of Potash
Urea Basf (Floranid)

Tennessee Copper & Chemical Corporation, Lockland, Cincinnati, Ohio.

Loma

I. P. Thomas & Son Company, 1000 Drexel Bldg., Philadelphia, Pa.

Castor Pomace
Dairymen's Special 0-10-10
Economy Fertilizer 3-12-3
I. P. Thomas 5-8-7
Long Island Special 4-8-7
Muriate of Potash
Nitrate of Soda
Pure Ground Bone
7% Guano 7-6-5
Sheep & Goat Manure
16% Superphosphate
Thomas' Tobacco Grower
Tip Top 3-10-6
Truckers High Grade Guano 4-8-4
Victor Potash Fertilizer 2-8-5

Triton Oil and Fertilizer Company, 101 Beekman St., New York City.

Nitrate of Soda
Triton 4-8-4 Fertilizer
Triton 5-8-7 Fertilizer

Wessel, Duval & Company, 1 Broadway, New York City.

Nitrate of Soda

Wilcox Fertilizer Company, 56 West Main St., Mystic, Conn.

Acid Phosphate
Castor Pomace
Ground Steamed Bone
Muriate of Potash
Nitrate of Soda Potash
Sulphate of Ammonia
Wilcox Corn Special 3-10-4
Wilcox Dry Ground Fish
Wilcox High Grade Fish & Potash 4-8-4
Wilcox Potato & Vegetable Phosphate 5-8-7
Wilcox Top Dresser 7-6-5

Virginia-Carolina Chemical Corporation, Richmond, Va.

Bloomaid
Fine Ground Bone
Nitrate of Soda

V-C Aroostook Potato Grower
V-C Fairway Fertilizer
V-C Fish & Potash Compound
V-C Phospho-Tobacco Dairy Absorbent
V-C 16% Superphosphate
V-C XXXX Fish & Potash

S. D. Woodruff & Sons, Orange, Conn.
Woodruff's Home Mixed Fertilizer

Worcester Rendering Company, Auburn, Mass.
Prosperity Brand Complete Dressing
Prosperity Brand Corn & Grain Fertilizer
Prosperity Brand Market Garden Fertilizer
Prosperity Brand Potato & Vegetable Fertilizer
Special Potato Fertilizer
Superior Top Dressing

INSPECTION OF 1929.

The Station Agent has visited 93 towns and villages in the State and has drawn 480 official samples of fertilizer, including all of the registered brands which could be found. These, together with samples submitted by purchasers and others interested, are classified as follows:

CLASSIFICATION OF FERTILIZERS ANALYZED IN 1929.

		No. of Samples	Page
I.	*Containing Nitrogen as the chief active ingredient:*		
	Nitrate of Soda	24	22
	Calcium Nitrate (Nitrate of Lime)	1	22
	Calurea	4	22
	Urea	1	23
	Sulphate of Ammonia	11	27
	Castor Pomace	47	27
	Cottonseed Meal	137	31
	Linseed Meal	19	32
II.	*Containing Phosphoric Acid as the chief active ingredient:*		
	Precipitated Bone Phosphate	12	39
	Superphosphate	18	39
	Basic Slag	1	39
III.	*Containing Potash as the chief ingredient:*		
	Carbonate of Potash	25	44
	Muriate of Potash	10	44
	Sulphate of Potash	19	44
	Sulphate of Potash-Magnesia	2	44
	Cotton Hull Ashes	60	45
IV.	*Containing Nitrogen and Potash:*		
	Nitrate of Potash	8	54
	Nitrate of Potash and Soda	3	54
V.	*Containing Nitrogen and Phosphoric Acid:*		
	Dry Ground Fish	38	56
	Tankage	11	57
	Ground Bone	35	57
VI.	*Mixed Fertilizer:*		
	Containing Nitrogen and Phosphoric Acid	5	66
	Containing Phosphoric Acid and Potash	2	66
	Containing Nitrogen and Potash	1	66
	Containing Nitrogen, Phosphoric Acid and Potash	248	67
	Special and Home Mixtures	67	93
VII.	*Miscellaneous:*		
	Sheep Manure, etc.	15	93
	Lime, etc.	7	93
	Other miscellaneous materials	40	93
	Collaborative check meals and fertilizers	42	93
	Total	913	

RAW MATERIALS CHIEFLY VALUABLE FOR NITROGEN.

NITRATE OF SODA.

Nitrate of Soda is a nitrogen salt containing not less than 15 percent of nitrogen, largely as sodium nitrate.[1] Ammonia equivalent to the nitrogen usually ranges from 18.2 to 19.5 percent, which represents 91 to 97 percent of nitrate of soda.

This raw material is obtained from the west coast of South America, chiefly from Chile, where large deposits of the crude salt are found. Until recently this has been practically the sole source of this form of agricultural nitrogen, but it now finds competition from nitrate made in Europe from synthetic nitric acid and soda. However, natural deposits of nitrate are not likely to be exhausted for many years to come and improvement in methods of refining will probably enable the natural product to maintain an important place in the fertilizer market.

Twenty-four samples were analyzed and the average nitrogen content found to be 15.53 per cent. All equalled or exceeded guaranties, except in two instances, one of which was negligible. The other involved a shortage of 0.3 per cent.

Eleven price quotations ranged from $65 to $80 a ton and averaged $70. Nitrogen from this source was bought at an average of about 25 cents a pound.

Analyses are given in Table I.

CALCIUM NITRATE.

This material is now being produced in quantity in Europe, where nitrogen of the air is converted into nitric acid and then combined with limestone to form calcium nitrate. It readily absorbs moisture and is shipped in drums or in paper lined bags to protect it from moisture.

The commercial article as offered in the fertilizer trade usually contains about 15.5 per cent of nitrogen. The one sample examined this year was guaranteed 15 per cent and 15.28 per cent was found.

Analysis appears in Table I.

CALUREA.

Calurea is a trade name for one of the synthetic ammoniates and is a combination of urea and calcium nitrate. About one-fifth of its nitrogen is derived from nitrate and the remainder is in organic form. It is generally guaranteed to contain 34 per cent of total nitrogen which is equivalent to 41.3 per cent of ammonia.

Four samples were examined this year, two of which were some-

[1] A.O.A.C. definition.

what under the guaranty of 34 per cent. The deficiencies were 0.32 and 0.48 per cent, respectively.

Analyses are given in Table I.

UREA.

This product is now made synthetically in considerable quantities in Europe from synthetic ammonia and carbon dioxide. It furnishes organic nitrogen in water soluble form. The usual guaranty is 46 per cent of nitrogen and the one sample examined this year fully met that specification. No price quotation was given, but nitrogen from this source may be valued at about 15 cents a pound.

Analysis appears in Table I.

TABLE I. ANALYSES OF NITRATE OF SODA, ETC.

Station No.	Manufacturer or Jobber.	Purchased, Sampled or Sent by	Per cent. Nitrogen. Found.	Per cent. Nitrogen. Guaranteed.
	Nitrate of Soda.			
1379	American Agricultural Chemical Co., New York	Station agent. Stock of S. P. Strople, New Britain	15.40	15.22
1405	Apothecaries Hall Co., Waterbury, Conn.	Station agent. Stock of J. A Glasnapp, West Cheshire	15.46	14.80
947	Apothecaries Hall Co., Waterbury, Conn.	Hatheway & Steane, Inc., Hartford	15.88	14.80
948	Apothecaries Hall Co., Waterbury, Conn.	Hatheway & Steane, Inc., Hartford	15.64	14.80
1271	Apothecaries Hall Co., Waterbury, Conn.	Hatheway & Steane, Inc., Hartford	15.60	14.80
1662	Apothecaries Hall Co., Waterbury, Conn.	Hatheway & Steane, Inc., Hartford	15.42	14.80
1720	Apothecaries Hall Co., Waterbury, Conn.	A. N. Shepard & Son., Hartford	15.74	14.80
1561	Armour Fertilizer Works New York	Station agent. Stock of Raven's Hardware Co., Meriden	15.66	14.81
1584	Associated Seed Growers, New Haven, Conn.	Station agent. Stock of Associated Seed Growers, Milford	15.82	15.00
1449	The Barrett Co., New York	Station agent. Stock of W. S. Eaton, Plainville	16.16	16.25
682	Berkshire Chemical Co., Bridgeport, Conn.	American Sumatra Tobacco Co., Bloomfield	15.28	15.00
683	Berkshire Chemical Co. Bridgeport, Conn.	American Sumatra Tobacco Co., Bloomfield	15.52	15.00
684	Berkshire Chemical Co. Bridgeport, Conn.	American Sumatra Tobacco Co., Bloomfield	15.48	15.00
763	Berkshire Chemical Co., Bridgeport, Conn.	American Sumatra Tobacco Co., Bloomfield	15.46	15.00
998	Berkshire Chemical Co. Bridgeport, Conn.	James T. Burgess, Thompsonville	15.58	15.00
1375	Berkshire Chemical Co. Bridgeport, Conn.	Station agent. Stock of J. A. Smith, Hamden	16.08	15.00
1369	Consolidated Rendering Co. Boston, Mass.	Station agent. Stock of H. D. Peters, Highwood	15.48	15.22
1443	Eastern States Farmers' Exchange, Springfield, Mass.	Station agent. Stock of Hoyt's Nurseries, New Canaan	15.68	15.00
1476	Olds & Whipple, Inc., Hartford, Conn.	Sation agent. Stock of F. T. Blish Hardware Co., So. Manchester	15.86	15.00
1415	The Rogers & Hubbard Co., Portland, Conn.	Station agent. Stock of Cadwell & Jones, Hartford	14.50	14.80
1399	Standard Phosphate & Acid Works, Baltimore, Md.	Station agent. Stock of Peter Aldo, Milford	15.08	15.00

TABLE I. ANALYSES OF NITRATE OF SODA, ETC.—*Concluded.*

Station No.	Manufacturer or Jobber.	Purchased, Sampled or Sent by	Per cent. Nitrogen. Found.	Per cent. Nitrogen. Guaranteed.
	Nitrate of Soda.			
1618	I. P. Thomas & Son, Philadelphia, Pa.	Station agent. Stock of Ira W. Beers, Hamden	15.36	15.00
1675	Triton Oil & Fertilizer Co. New York	Station agent. Stock of F. H. Woodruff & Son, Milford	15.48	14.80
1630	Virginia-Carolina Chemical Co., New York	Station agent. Stock of Stanley Svea Coal Co., New Britain	15.12	14.80
	Calcium Nitrate. (Nitrate of Lime)			
1615	Synthetic Nitrogen Products Co., New York	Station agent. Stock of Olds & Whipple, Inc., Hartford	15.28	15.00
	Calurea.			
1704	Synthetic Nitrogen Products Co., New York	L. Wetstone & Sons, Hartford	34.00	34.00
1613	Synthetic Nitrogen Products Co., New York	Station agent. Stock of Olds & Whipple, Inc., Hartford	33.68	34.00
1902	Synthetic Nitrogen Products Co., New York	Station agent. Stock of John Richards, So. Glastonbury	34.08	34.00
2031	Synthetic Nitrogen Products Co., New York	Chas. D. Lewis, Hartford	33.52	34.00
	Urea.			
1614	Synthetic Nitrogen Products Co., New York	Station agent. Stock of Olds & Whipple, Inc., Hartford	46.04	46.00

TABLE II. ANALYSES OF SULPHATE OF AMMONIA.

Station No.	Manufacturer or Jobber.	Purchased, Sampled or Sent by	*Per cent. Nitrogen. Found.	Guaranteed.
1389	American Agricultural Chemical Co., New York	Station agent. Stock of S. P. Strople, New Britain	20.68	20.56
1564	Armour's Fertilizer Works New York	Station agent. Stock of F. A. Bartlett Tree Expert Co., Stamford	20.80	20.56
1409	Apothecaries Hall Co., Waterbury, Conn.	Station agent at factory	21.10	20.58
1403	The Barrett Co., New York	Station agent. Stock of Berkshire Chemical Co., Bridgeport	21.04	20.75
1402	The Barrett Co., New York	Station agent. Stock of Berkshire Chemical Co., Bridgeport	20.68	20.50
1423	Consolidated Rendering Co., Boston, Mass.	Station agent. Stock of L. T. Frisbie Co., New Haven	20.58	20.50
1794	Eastern States Farmers' Exchange, Springfield, Mass.	Station agent. Stock of C. D. Prentice, North Haven	20.64	20.50
1876	Ford Motor Co., Detroit Mich.	Station agent. Stock of J. N. Adams, Willimantic	20.96	20.80
1469	Olds & Whipple, Inc., Hartford, Conn.	Station agent at factory	20.72	20.58
1397	*Standard Phosphate & Acid* Works, Baltimore, Md.	*Station agent. Stock of Geo. S.* Jennings, Southport	19.92	20.56
1641	Wilcox Fertilizer Co., Mystic, Conn.	Station agent at factory	20.76	20.56

SULPHATE OF AMMONIA.

In this country sulphate of ammonia is made almost entirely from sulphate acid and ammonia obtained in the production of coke and illuminating gas. In Europe it is now made on a large scale from synthetic ammonia, gypsum and carbon dioxide.

So called "Arcadian" sulphate of ammonia is specially treated, dried and screened to remove lumps and insure good mechanical *condition.*

The grade offered for fertilizer purposes will contain about 20.5 per cent of nitrogen and is generally so guaranteed. All of the eleven samples examined this year met or exceeded guarantees with the exception of No. 1397, which was deficient by about 0.6 per cent. The average nitrogen content for all samples was 20.71 per cent. Ton price quotations were so few and variable that average cost to the purchaser cannot be fairly estimated, but a fair valuation for nitrogen from this source may be taken at about 14.5 cents a pound.

Analyses are given in Table II.

CASTOR POMACE.

Castor Pomace is the ground residue left after removal of the oil from castor beans. It should be stored where farm animals will not have access, as it is poisonous if eaten.

This raw material is chiefly valuable as a fertilizer for its nitrogen, although it also contains small amounts of phosphoric acid and potash.

Forty-seven samples were examined, all sold under guaranties of about 4.5 per cent nitrogen. The average nitrogen found was 4.75 per cent and only five samples failed to meet guaranties by amounts greater than 0.1 per cent. There has been some impression that castor pomace was of rather poorer quality than nsual this year, but our figures show no significant variation in quality. Averages for nitrogen for the past three years, according to our records are 4.75, 5.10 and 4.80 per cent as compared with 4.75 this year.

The prevailing ton price, so far as prices were quoted to our agent, has been $30, and the average is $30.15. With no allowance for phosphoric acid and potash, nitrogen from this source has cost about 31.5 cents a pound. This compares with 30 cents last year and with 24 and 23.2 cents for the two years preceding.

Analyses are given in Table III.

TABLE III ANALYSES OF CASTOR POMACE.

Station No.	Manufacturer or Jobber, Car No. or Mark	Purchased, Sampled or Sent by	Per cent. Nitrogen. Found.	Per cent. Nitrogen. Guaranteed.
	The American Agricultural Chemical Co., New York City.			
1735	....	Station agent. Stock of E. J. Bantle, Glastonbury	4.58	4.5
	Apothecaries Hall Co., Waterbury, Conn.			
1406	....	Station agent. Stock of J. A. Glasnapp, West Cheshire	4.54	4.5
822	Car No. 11645	Hatheway & Steane, Inc., Hartford	4.66	4.5
823	Car No. 11264	Hatheway & Steane, Inc., Hartford	5.06	4.5
824	Car No. 13716	Hatheway & Steane, Inc., Hartford	5.24	4.5
825	Car No. 570146	Hatheway & Steane, Inc., Hartford	4.46	4.5
826	Car No. 203652	Hatheway & Steane, Inc., Hartford	5.32	4.5
857	Car No. 17597	Hatheway & Steane, Inc., Hartford	5.10	4.5
949	Car No. 515318	Hatheway & Steane, Inc., Hartford	5.00	4.5
950	Car No. 533981	Hatheway & Steane, Inc., Hartford	4.10	4.5
951	Car No. 41961	Hatheway & Steane, Inc., Hartford	4.49	4.5
1268	Car No. 10133	Hatheway & Steane, Inc., Hartford	5.19	4.5
1657	Truck No. 4791	Hatheway & Steane, Inc., Hartford	5.52	4.5
1722	*Car No. 17301*	*A. N. Shepard & Son., Hartford*	4.54	4.5
	Armour Fertilizer Works, New York City.			
1949	....	Station agent. Stock of James T. Caffrey, Cromwell	4.62	4.5
	Baker Castor Oil Co., New York City.			
895	Car No. 10850	American Sumatra Tobacco Co. Bloomfield	4.88	4.5
896	Car No. 35839	American Sumatra Tobacco Co. Bloomfield	5.24	4.5

TABLE III. ANALYSES OF CASTOR POMACE—*Continued.*

Manufacturer or Jobber, Car No. or Mark	Purchased, Sampled or Sent by	Per cent. Nitrogen. Found.	Per cent. Nitrogen. Guaranteed.
Baker Castor Oil Co., New York City.			
Car No. 17182	American Sumatra Tobacco Co., Bloomfield	4.77	4.50
Car No. 17911	American Sumatra Tobacco Co. Bloomfield	4.50	4.50
	Station agent. Stock of Olds & Whipple, Inc., Hartford	4.98	4.50
	Station agent. Stock of John Richards, So. Glastonbury	4.80	4.50
Berkshire Chemical Co., Bridgeport, Conn.			
Car No. 171163	Station agent. Stock of Cullman Bros. Hartford	4.34	4.52
	Station agent. Stock of James T Burgess, Thompsonville	4.58	4.52
	Station agent. Stock of Lester W Lloyd, Suffield	4.43	4.52
	Station agent. Stock of G. A. Peckham, Suffield	4.50	4.52
Car N. H. 167387	Cullman Bros., Hartford	4.59	4.52
Car B. & M. 70062	Cullman Bros., Hartford	4.66	4.52
	James T. Burgess, Thompsonville	4.21	4.52
Car No. 171163	Cullman Bros., Hartford	4.15	4.52
Car No. 163194 N. H.	Cullman Bros., Hartford	4.26	4.52
Car N. H. 150236	Cullman Bros., Hartford	4.90	4.52
Car N. H. 164131	Cullman Bros., Hartford	4.84	4.52
Car N. H. 164215	Cullman Bros., Hartford	5.00	4.52
Car C. of N. *J. 30208*	Cullman Bros., Hartford	4.70	4.52
Car P. R. R. 516474	Spencer Bros., Inc., Suffield	4.81	4.52
Car N. Y. 71365	Spencer Bros., Inc., Suffield	4.76	4.52
E. D. Chittenden Co., Bridgeport, Conn.			
	Station agent. Stock of J. P. Norton, Broad Brook	4.58	4.50
Consolidated Rendering Co., Boston, Mass.			
	Station agent. Stock of L. T. Frisbie Co., New Haven	4.95	4.52
Spencer Kellogg & Sons, Buffalo, N. Y.			
	Station agent. Stock of S. D. Woodruff & Sons, Orange	4.62	4.52

TABLE III. ANALYSES OF CASTOR POMACE—*Concluded.*

Station No.	Manufacturer or Jobber, Car No. or Mark	*Purchased, Sampled or Sent by*	Per cent. Nitrogen. Found.	Per cent. Nitrogen. Guaranteed.
	Mapes Formula & Peruvian Guano Co., New York City.			
1414	....	*Station agent. Stock of Mapes Branch, Hartford*	4.76	4.52
1285	Car C. N. J. 21191	John P. Cranouski, Poquonock ..	4.61	4.52
	Olds & Whipple, Inc., Hartford, Conn.			
2065	....	Station agent at factory	4.53	4.53
1687	....	Silberman & Kahn, Hartford	5.35	4.53
1707	Car 98792	L. Wetstone & Sons, Hartford ..	4.86	4.53
1780	Car P. R. R. 38403	Silberman & Kahn, Hartford	4.77	4.53
	Standard Wholesale Phosphate & Acid Works, Baltimore, Md.			
1921	....	Station agent. Stock of H. H. McKnight, Ellington	5.36	4.52
	Wilcox Fertilizer Co., Mystic, Conn.			
2045	....	Station agent. Stock of Patrick Foram, East Hartford	4.56	4.52

COTTONSEED MEAL.

In Connecticut, cottonseed meal is largely used for fertilizer purposes, particularly in mixtures for tobacco. It is sold, however, under classifications as laid down by the Association of Feed Control Officials of the United States, which are as follows:

"*Cottonseed Meal* is a product of the cottonseed only, composed principally of the kernel with such portion of the hull as is necessary in the manufacture of oil, provided that nothing shall be recognized as cottonseed meal that does not conform to the foregoing definition and that does not contain at least 36 per cent of protein. Cottonseed meal shall be graded and classed as follows:

1. "*Cottonseed Meal, Prime Quality.* Cottonseed meal, prime quality, must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellowish, not brown or reddish, free from excessive lint, and shall contain not less than 36 per cent of protein. It shall be designated and sold according to its protein content. Cottonseed meal with 36 per cent of protein shall be termed '36 per cent Protein Cottonseed Meal, Prime Quality', and higher grades similarly designated (as '43 per cent Protein Cottonseed Meal, Prime Quality'), etc.

2. "*Cottonseed Meal, Off Quality.* Cottonseed meal not fulfilling the above requirements as to color, odor and texture shall be graded '36 per cent Protein Cottonseed Meal, Off Quality,' and higher grades similarly designated."

The grade chiefly used this year for fertilizer has been that containing 6.58 per cent nitrogen (41 per cent protein).

One hundred and thirty-seven samples have been analyzed, most of them submitted by purchasers. Such samples should be accompanied by complete information as to manufacturer and guaranty, but in some instances this information, although requested, is not obtained. Thus thirteen samples appear in our summary without guaranties. About three-quarters of the total samples represented the 6.58 per cent nitrogen grade; there were 11 samples of the 6.88 per cent grade and 12 of the 5.75 per cent grade. The average nitrogen content for the groups in the order named was 6.60, 6.87 and 5.62 per cent.

Price quotations for the several grades, making no allowance for the phosphoric acid and potash per cent, show that nitrogen has cost 40.5 cents per pound in the 6.58 per cent meal; 40.8 cents per pound in the 5.75 per cent grade; and 40.7 cents in the 6.88 per cent grade.

Of one hundred and twenty-four samples with known guaranties, eighty substantially equalled or exceeded their guaranties and forty-four did not. That is to say that more than one-third of the samples fell below guaranty by more than 0.1 per cent of nitrogen. While purchasers are compensated by manufacturers and

jobbers for shortages by means of rebates, the necessity for this appears to arise from attempting to grade this product too closely. Reference to the group averages noted above shows that the nitrogen found in meals of the several groups barely meets the requirements in two instances and in one fails to do so.

Analyses are given in Table IV.

LINSEED MEAL.

This product is also used in tobacco fertilizer mixtures in conjunction with, or as a substitute for, cottonseed meal to supply organic nitrogen. So-called "old process" meal is made by grinding the press cake left after removal of the oil from flaxseed by crushing, cooking and pressing. In "new process" meal the oil has been removed by the use of solvents.

Nineteen samples were examined this year, all submitted by purchasers. This material is generally guaranteed 5.5 per cent nitrogen. The average nitrogen found this year is 5.5 per cent. At the average of quoted prices nitrogen from this source has cost a little more than 50 cents a pound. Last year the cost was estimated from similar data at 48 cents.

Analyses are given in Table IV.

TABLE IV. ANALYSES OF COTTONSEED AND LINSEED MEALS.

Manufacturer or Jobber, Car No. or Mark	Purchased, Sampled or Sent by	Per cent. Nitrogen. Found.	Per cent. Nitrogen. Guaranteed.
Apothecaries Hall Co., Waterbury, Conn.	**Cottonseed Meal.**		
....	Station agent at factory.........	6.80	6.58
Car No. 51081	Hatheway & Steane, Inc., Hartford	6.70	6.58
Car No. 50644	Hatheway & Steane, Inc., Hartford	6.58	6.58
Car No. 60166	Hatheway & Steane, Inc., Hartford	6.54	6.58
Car No. 55816	Hatheway & Steane, Inc., Hartford	6.82	6.58
Car No. 519348	Hatheway & Steane, Inc., Hartford	6.33	6.58
Car No. 174494	Hatheway & Steane, Inc., Hartford	6.32	6.58
Car No. 55314	Hatheway & Steane, Inc., Hartford	6.58	6.58
Car No. 55922	Hatheway & Steane, Inc., Hartford	6.47	6.58
Car No. 7415	Hatheway & Steane, Inc., Hartford	6.59	6.58
Car No. 58471	Hatheway & Steane, Inc., Hartford	6.14	6.58
Car No. 55496	Hatheway & Steane, Inc., Hartford	6.53	6.58
Car No. 311306	Hatheway & Steane, Inc., Hartford	6.64	6.58
Car No. 166052	Hatheway & Steane, Inc., Hartford	6.62	6.58
Car No. 409603	Hatheway & Steane, Inc., Hartford	6.48	6.58
Car No. 167589	Hatheway & Steane, Inc., Hartford	6.71	6.58
Car No. 170331	Hatheway & Steane, Inc., Hartford	6.54	6.58
Car No. 163137	Hatheway & Steane, Inc., Hartford	6.50	6.58
Car No. 405457	Hatheway & Steane, Inc., Hartford	6.58	6.58
Car No. 160009	Hatheway & Steane, Inc., Hartford	6.58	6.58
Car No. 162958	Hatheway & Steane, Inc., Hartford	6.66	6.58

TABLE IV. ANALYSES OF COTTONSEED AND LINSEED MEALS—*Continued.*

Station No.	Manufacturer or Jobber, Car No. or Mark	Purchased, Sampled or Sent by	Per ce[nt] Nitrog[en] Found.
	Apothecaries Hall Co., Waterbury, Conn.		
1503	Car No. 162120	Hatheway & Steane, Inc., Hartford	6.53
1504	Car No. 161055	Hatheway & Steane, Inc., Hartford	6.42
1505	Car No. 47379	Hatheway & Steane, Inc., Hartford	6.72
1625	Car No. 15341	Hatheway & Steane, Inc., Hartford	6.33
8820	Car No. 156920	Hatheway & Steane, Inc., Hartford	6.66
8828	Car No. 7611	Hatheway & Steane, Inc., Hartford	6.66
8829	Car No. 158940	Hatheway & Steane, Inc., Hartford	6.73
8830	Car No. 55363	Hatheway & Steane, Inc., Hartford	6.73
	Ashcraft-Wilkinson Co., Atlanta, Ga.		
1951	Paramount	Station agent. Stock of Amos D. Bridge's Sons, Hazardville	5.65
876	Car N. H. 167451	Cullman Bros., Hartford	6.92
877	Car N. H. 71784	Cullman Bros., Hartford	6.05
878	Car N. H. 165813	Cullman Bros., Hartford	6.83
881	Helmet, Car L & N. 15890	Cullman Bros., Hartford	6.67
882	Helmet, Car.B. & O. 194016	Cullman Bros., Hartford	6.78
883	Helmet, Car L. & N. 14274	Cullman Bros., Hartford	6.83
884	Helmet, Car N. H. 168439	Cullman Bros., Hartford	6.74
885	Helmet, Car No. 150244	Cullman Bros., Hartford	6.56
1029	Helmet, Car N. H. 169671	Cullman Bros., Hartford	6.60
1286	Helmet, Car No. 163490	I. Kaffenburgh & Sons, Inc., Hartford	6.70
1287	Helmet, Car No. 231485	I. Kaffenburgh & Sons, Inc., Hartford	6.55
1288	Helmet, Car No. 30347	I. Kaffenburgh & Sons, Inc., Hartford	6.45
1289	Helmet, Car No. 162083	I. Kaffenburgh & Sons, Inc., Hartford	6.68
1290	Helmet, Car No. 342072	I. Kaffenburgh & Sons, Inc., Hartford	6.20
1291	Helmet, Car No. 62951	I. Kaffenburgh & Sons, Inc., Hartford	6.17
1292	Helmet, Car No. 166275	I. Kaffenburgh & Sons, Inc., Hartford	6.48

TABLE IV. ANALYSES OF COTTONSEED AND LINSEED MEALS—*Continued.*

Manufacturer or Jobber, Car No. or Mark	Purchased, Sampled or Sent by	Per cent. Nitrogen. Found.	Per cent. Nitrogen. Guaranteed.
Ashcraft-Wilkinson Co., Atlanta, Ga.			
Helmet, Car No. 160890	I. Kaffenburgh & Sons, Inc., Hartford	6.59	6.56
Helmet, Car C. N. 428278	I. Kaffenburgh & Sons, Inc., Hartford	6.57	6.56
Car C. N. 409048	I. Kaffenburgh & Sons, Inc., Hartford	6.56	6.56
Helmet, Car C. N. E. 10559	I. Kaffenburgh & Sons, Inc., Hartford	6.56	6.56
Monarch, Car N. Y. 84844 and M. L. & T. 53287	Spencer Bros., Inc., Suffield	6.94	6.88
Monarch, Car C. of Ga. 58030	Spencer Bros., Inc., Suffield	6.90	6.88
Monarch, Car N. Y. 166393 and 25254	Spencer Bros., Inc., Suffield	7.02	6.88
Helmet, Car Pa. 572583	Spencer Bros., Inc., Suffield	6.49	6.56
Paramount, Car R. I. 46524	Spencer Bros., Inc., Suffield	5.32	5.76
Helmet, Car W. of A. 959	Spencer Bros., Inc., Suffield	6.53	6.56
Monarch, Car N. Y. 160303 and 37727	Spencer Bros., Inc., Suffield	7.08	6.88
Helmet, Car I. C. 340224	Spencer Bros., Inc., Suffield	6.71	6.56
Helmet, Car I. C. 159550	Spencer Bros., Inc., Suffield	6.56	6.56
Monarch, Car N. Y. 163385 and INO 53564	Spencer Bros., Inc., Suffield	7.02	6.88
Monarch, Car B. & O. 192375	Spencer Bros., Inc., Suffield	6.90	6.88
F. W. Brode Corp., Memphis, Tenn.			
Owl Brand 41%	Station agent. Stock of F. N. Buckland, So. Manchester	6.28	6.56
Owl Brand 43%	Geo. T. Soule Co., New Milford	6.60	6.88
Owl Brand 43%	Geo. T. Soule Co., New Milford	6.54	6.88
Owl Brand 43%	Geo. T. Soule Co., New Milford	6.70	6.88
Humphreys-Godwin Co., Memphis, Tenn.			
Dixie	Station agent. Stock of C. S. Barnum, Danbury	6.66	6.58
Dixie	Station agent. Stock of Frank Ford, Suffield	6.58	6.58
Bull	Station agent. Stock of Bloomfield Farmers' Exchange, Bloomfield	6.86	6.88
Danish	Station agent. Stock of Geo. S. Phelps, Thompsonville	5.78	5.75

TABLE IV. ANALYSES OF COTTONSEED AND LINSEED MEALS—*Continued.*

Station No.	Manufacturer or Jobber, Car No. or Mark	Purchased, Sampled or Sent by	Per cent. Nitrogen. Found.	Per cent. Nitrogen. Guaranteed.
	Humphreys-Godwin Co., Memphis, Tenn.			
1899	Dixie	Station agent. Stock of John Richards, So. Glastonbury	6.37	6.58
1297	Dixie, Car No. 164145	J. Bermant, Ellington	6.48	6.58
1298	Dixie, Car No. 168084	J. Bermant, Ellington	6.69	6.58
1299	Dixie, Car No. 35114	J. Bermant, Ellington	6.39	6.58
1330	Bull, Car N. H. 71512	Cullman Bros., Inc., Hartford	7.02	6.88
873	Dixie, Car N. H. 169423	Cullman Bros., Inc., Hartford	6.41	6.58
874	Dixie, Car N. H. 163452	Cullman Bros., Inc., Hartford	6.58	6.58
875	Dixie, Car No. 160484	Cullman Bros., Inc., Hartford	6.45	6.58
1331	Dixie, Car N.H. 90428	Cullman Bros., Inc., Hartford	6.67	6.58
1332	Dixie, Car N. H. 160152	Cullman Bros., Inc., Hartford	6.66	6.58
1333	Dixie, Car N. H. 87398	Cullman Bros., Inc., Hartford	6.58	6.58
1334	Dixie, Car N. H. 79245	Cullman Bros., Inc., Hartford	6.54	6.58
1335	Dixie, Car N.H. 164093	Cullman Bros., Inc., Hartford	6.62	6.58
1336	Dixie, Car N. H. 158079	Cullman Bros., Inc., Hartford	6.60	6.58
1337	Dixie, Car N. H. 160898	Cullman Bros., Inc., Hartford	6.68	6.58
1338	Dixie, Car No. 162523	Cullman Bros., Inc., Hartford	6.58	6.58
1339	Dixie, Car No. 89648	Cullman Bros., Inc., Hartford	6.58	6.58
1340	Dixie, Car No. 76146	Cullman Bros., Inc., Hartford	6.59	6.58
1550	....	J. R. Debone, East Hartford	6.36	
980	Dixie, Car No. 62046	L. B. Haas & Co., Inc., Hartford	6.39	6.58
981	Dixie, Car No. 245109	L. B. Haas & Co., Inc., Hartford	6.83	6.58
982	Dixie, Car No. 45358	L. B. Haas & Co., Inc., Hartford	6.50	6.58
983	Dixie, Car No. 15145	L. B. Haas & Co., Inc., Hartford	6.42	6.58
984	Dixie, Car No. 165952	L. B. Haas & Co., Inc., Hartford	6.45	6.58
985	Dixie, Car No. 44183	L. B. Haas & Co., Inc., Hartford	6.32	6.58
1032	Dixie, Car No. 421771	L. B. Haas & Co., Inc., Hartford	6.52	6.58
1033	Dixie, Car No. 16441	L. B. Haas & Co., Inc., Hartford	6.44	6.58
1344	Dixie, Car No. 171241	L. B. Haas & Co., Inc., Hartford	6.57	6.58
914	Dixie	Huntington Bros., Windsor	6.42	6.58
915	Dixie	Huntington Bros., Windsor	6.61	6.58
916	Dixie	Huntington Bros., Windsor	6.46	6.58
917	Dixie	Huntington Bros., Windsor	6.46	6.58
744	Dixie	S. F. Holcomb & Son, West Granby	6.40	6.58
901	Dixie	S. F. Holcomb & Son, West Granby	6.64	6.58
1906	Dixie, Car No. 163938	Max Lavitt, Ellington	6.37	6.58
1907	Dixie, Car No. 166562	Max Lavitt, Ellington	6.59	6.58
1908	Dixie, Car No. 170190	Max Lavitt, Ellington	6.47	6.58
1284	Dixie	H. C. Nelson, West Suffield	6.58	6.58
906	Dixie, Car C. G. A. 51140	A. N. Shepard, Hartford	6.61	6.58
1897	Dixie, Car No. 1	M. Silverberg, Ellington	6.42	6.58

TABLE IV. ANALYSES OF COTTONSEED AND LINSEED MEALS—*Continued.*

Manufacturer or Jobber, Car No. or Mark	Purchased, Sampled or Sent by	Per cent. Nitrogen. Found.	Per cent. Nitrogen. Guaranteed.
Humphreys-Godwin Co., Memphis, Tenn.			
Dixie, Car No. 2	M. Silverberg, Ellington	6.46	6.58
Danish, Car Southern 167164	Spencer Bros., Inc., Suffield	5.66	5.76
Danish, Car A. C. L. 50466	Spencer Bros., Inc., Suffield	5.63	5.76
Danish, Car C. M. St. P. 708260	Spencer Bros., Inc., Suffield	5.70	5.76
Danish, Car Southern 168634	Spencer Bros., Inc., Suffield	5.70	5.76
Danish, Car Southern 131844	Spencer Bros., Inc., Suffield	5.66	5.76
Danish, Car A. C. L. 30742	Spencer Bros., Inc., Suffield	5.73	5.76
Danish, Car A. C. L. 17430	Spencer Bros., Inc., Suffield	5.58	5.76
Car No. 1	Henry E. Wells, Warehouse Point	6.55	....
Car No. 2	Henry E. Wells, Warehouse Point	6.65	....
Dixie, Car No. 163226	L. Wetstone & Sons, Hartford	6.44	6.58
Dixie, Car No. 341534	L. Wetstone & Sons, Hartford	6.31	6.58
Dixie, Car No. 166772	L. Wetstone & Sons, Hartford	6.55	6.58
Dixie, Car No. 80678	L. Wetstone & Sons, Hartford	6.30	6.58
Dixie, Car No. 81014	L. Wetstone & Sons, Hartford	6.40	6.58
Dixie, Car S. P. 20654	L. Wetstone & Sons, Hartford	6.34	6.58
International Agricultural Corp., Atlanta, Ga.			
Zenith	W. S. Pinney, Suffield	6.66	6.56
L. B. Lovitt Co., Memphis, Tenn.			
"Lovit" 36%, Car I. C. 190247	A. N. Shepard & Son, Hartford	5.58	5.76
"Lovit" 36%, Car I. C. 173354	A. N. Shepard & Son, Hartford	5.60	5.76
Marianna Sales Co., Memphis, Tenn.			
White Mule	Charles J. Hartz, Burnside	6.16	6.58
Olds & Whipple, Inc., Hartford, Conn.			
Car No. 161099	L. B. Haas & Co., Hartford	6.53	....
....	The Hartman Tobacco Co., Hartford	6.95	....
....	The Hartman Tobacco Co., Hartford	7.13	....
....	Silberman & Kahn, Hartford	6.48	....
Car No. 161306	Silberman & Kahn, Hartford	6.66	....
Car No. 163813	Silberman & Kahn, Hartford	6.58	....

TABLE IV. ANALYSES OF COTTONSEED AND LINSEED MEALS—*Concluded.*

Station No.	Manufacturer or Jobber, Car No. or Mark	Purchased, Sampled or Sent by	Per cent. Nitrogen. Found.	Per cent. Nitrogen. Guaranteed.
	Manufacturer Unknown.			
1549		J. R. Debone, East Hartford	6.55	....
2070		Karl C. Kulle, Suffield	6.43	6.56
	Archer-Daniels-Midland Co., Minneapolis, Minn.	**Linseed Meal.**		
986	Car No. 93172	L. B. Haas & Co., Inc., Hartford	5.18	5.12
1345	Car No. 170308	L. B. Haas & Co., Inc., Hartford	5.18	5.12
8833	Car No. 10432	Hatheway & Steane, Inc., Hartford	5.64	....
8822	Car No. 94653	Hatheway & Steane, Inc., Hartford	5.63	....
8823	Car No. 9027	Hatheway & Steane, Inc., Hartford	5.64	....
918		Huntington Bros., Windsor	5.25	....
1703	Car No. 161946	L. Wetstone & Sons, Hartford	5.15	5.12
	Kellogg and Miller, Inc., Amsterdam, N. Y.			
863	Car No. 95173	Hatheway & Steane, Inc., Hartford	5.57	5.44
864	Car No. 219843	Hatheway & Steane, Inc., Hartford	5.52	5.44
940	Car No. 33185	Hatheway & Steane, Inc., Hartford	5.41	5.44
941	Car No. 254108	Hatheway & Steane, Inc., Hartford	5.48	5.44
942	Car No. 48392	Hatheway & Steane, Inc., Hartford	5.61	5.44
943	Car No. 214525	Hatheway & Steane, Inc., Hartford	5.59	5.44
944	Car No. 220918	Hatheway & Steane, Inc., Hartford	5.67	5.44
1661	Truck No. 4791	Hatheway & Steane, Inc., Hartford	5.25	5.44
1721	Car No. 169078	A. N. Shepard & Sons, Hartford	5.48	5.44
1178	Car No. 180590	Hatheway & Steane, Inc., Hartford	5.45	5.44
1179	Car No. 35447	Hatheway & Steane, Inc., Hartford	5.57	5.44
1180	Car No. 229149	Hatheway & Steane, Inc., Hartford	5.52	5.44

II. RAW MATERIALS CHIEFLY VALUABLE FOR PHOSPHORIC ACID.

PRECIPITATED BONE PHOSPHATE.

This material is a by-product obtained in the manufacture of gelatin and glue stock from bone. Bones are treated with hydrochloric acid and the acid solution then treated with lime or limestone to precipitate the phosphates. The term "precipitated phosphate" is generally used to designate the article derived from bone as here described; but it would be descriptive also of material of similar substance and quality derived from other sources. The terms "bone phosphate" or "precipitated bone phosphate" are correctly applied only to those concentrated phosphates derived from bone.

Precipitated bone phosphate is valuable for its high available phosphoric acid, the guaranty for which is generally placed at 36 or 38 per cent.

Twelve samples were examined this year, three of which were sampled by the Station Agent and the others by purchasers. Guaranties, so far as given, were met with substantial margins of safety. There were three price quotations, all $45.00 a ton, at which available phosphoric acid has cost the purchaser 5.3 cents a pound.

Analyses are given in Table V.

SUPERPHOSPHATE.

This important base material, formerly called "acid phosphate," is made by treating phosphate rock with sulphuric acid, which results in a mixture of mono-calcium phosphate and calcium sulphate or gypsum. The phosphoric acid is largely in available form and generally is guaranteed at 16 per cent.

Eighteen samples were analyzed, four of which fell below guaranties by amounts greater than 0.25 per cent. The deficiencies ranged from 0.3 to 1 per cent. The average of all samples is 16.65 per cent and the average of quoted prices is about $25.00 per ton, thus available phosphoric acid from this source has cost approximately 7.5 cents a pound this year.

Analyses are given in Table VI.

Sample 1629, Phospho Tobacco, is classed with the superphosphates, but it contains about 3 per cent less available phosphoric acid and is guaranteed accordingly.

BASIC SLAG.

Basic slag is a by-product in the manufacture of steel from phosphatic iron ores. It should contain not less than 12 per cent

of total phosphoric acid, of which not less than 80 per cent should be "available" by the Wagner method.[1]

One sample, **1956**, from stock of Apothecaries Hall Company, was analyzed. In contained 16.58 per cent of total phosphoric acid and 14.43 per cent available. The material meets the requirements for standard basic slag, but is about 0.5 per cent under the guaranty given by the seller.

[1] Assoc. of Official Agricultural Chemists, Proc. of Oct. 1925.

TABLE V. ANALYSES OF PRECIPITATED BONE PHOSPHATE.

Station No.	Manufacturer or Wholesale Dealer.	Place of Sampling.	Phosphoric Acid.			
			Citrate Insoluble.	Total.	"Available." Found.	"Available." Guaranteed.
	Sampled by Station.		%	%	%	%
1410	Apothecaries Hall Co., Waterbury	At factory	0.57	39.10	38.53	36.00
1879	Eastern States Farmers' Exchange, Springfield, Mass.	Frank V. Williams, Buckland	0.05	45.53	45.48	38.00
1460	Olds & Whipple, Inc., Hartford	At factory	0.25	44.40	44.15	38.00
	Sampled by Purchaser.					
945	Apothecaries Hall Co., Waterbury	Hatheway & Steane, Inc., Hartford	0.40	39.72	39.32	36.00
946	Apothecaries Hall Co., Waterbury	Hatheway & Steane, Inc., Hartford	0.56	40.92	40.36	36.00
1175	Apothecaries Hall Co., Waterbury	Hatheway & Steane, Inc., Hartford	0.75	39.25	38.50	36.00
1719	Apothecaries Hall Co., Waterbury	A. N. Shepard & Son, Hartford	0.42	39.10	38.68	36.00
920	Olds & Whipple, Inc., Hartford	Huntington Bros., Windsor	0.15	46.72	46.57	38.00
2030	Olds & Whipple, Inc., Hartford	Lester Lloyd, Suffield	0.30	46.10	45.80	38.00
1688	Olds & Whipple, Inc., Hartford	Silberman & Kahn, Hartford	0.30	46.10	46.50	38.00
1774	Olds & Whipple, Inc., Hartford	Silberman & Kahn, Hartford	0.30	45.78	45.48	38.00
1702	Olds & Whipple, Inc., Hartford	L. Wetstone & Sons, Hartford	0.60	39.50	38.90	38.00

TABLE VI. ANALYSES OF SUPERPHOSPHATE (ACID PHOSPHATE).

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Phosphoric Acid. Citrate Insoluble.	Phosphoric Acid. Total.	Phosphoric Acid. "Available." Found.	Phosphoric Acid. "Available." Guaranteed.
	Sampled by Station.		%	%	%	%
1496	American Agricultural Chemical Co., New York City	New Canaan: Clap Board Hill Farm	0.65	17.12	16.47	16.00
1446	Apothecaries Hall Co., Waterbury	Waterbury: Templeton's Hardware Co.	1.60	17.28	15.68	16.00
1568	Armour Fertilizer Works, New York City	*Stamford*: F. A. Bartlett Tree Expert Co.	0.48	20.50	20.02	20.00
1576	Armour Fertilizer Works, New York City	Meriden: Raven's Hardware Co.	0.69	17.16	16.47	16.00
1585	Associated Seed Growers, New Haven	Milford: Associated Seed Growers	0.43	17.25	16.82	16.00
1373	Berkshire Chemical Co., Bridgeport	Hamden: J. A. Smith	0.15	17.21	17.06	16.00
1368	Consolidated Rendering Co., Boston, Mass.	Highwood: H. D. Peters	0.10	19.80	19.70	20.00
1600	Consolidated Rendering Co., Boston, Mass.	Wallingford: Laden Bros.	1.53	17.60	16.07	16.00
1425	Eastern States Farmers' Exchange, Springfield, Mass.	New Canaan: Hoyt's Nurseries	0.76	16.73	15.97	16.00
1500	Eastern States Farmers' Exchange, Springfield, Mass.	Southington: Julius Lewis	0.43	16.60	16.17	16.00
1475	Olds & Whipple, Inc., Hartford	So. Manchester: F. T. Blish Hardware Co.	1.40	16.40	15.00	16.00
1472	*The Rogers & Hubbard Co., Portland*	*Sampled at factory*	0.15	17.76	17.61	16.00
1398	Standard Phosphate & Acid Works, Baltimore, Md.	Southport: Geo. S. Jennings	0.58	16.15	15.57	16.00

TABLE VI. ANALYSES OF SUPERPHOSPHATE (ACID PHOSPHATE)—*Concluded.*

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Phosphoric Acid. Citrate Insoluble.	Phosphoric Acid. Total.	Phosphoric Acid. "Available." Found.	Phosphoric Acid. "Available." Guaranteed.
	Sampled by Station.		%	%	%	%
1619	I. P. Thomas & Son, Philadelphia, Pa.	*Hamden: Ira W. Beers*	*0.28*	*17.08*	*16.80*	*16.00*
1633	Virginia-Carolina Chemical Co., New York City	New Britain: Stanley Svea Coal Co.	1.25	17.30	16.05	16.00
1634	Wilcox Fertilizer Co., Mystic	*Sampled at factory*	*0.10*	*18.12*	*18.02*	*17.00*
	Phospho Tobacco.					
1629	Virginia-Carolina Chemical Co., New York City	New Britain: Stanley Svea Coal Co.	0.78	13.89	13.11	13.00
	Sampled by Purchaser.					
2029	United States Guano Co., Baltimore, Md.	Suffield: Lester Lloyd	0.20	17.30	17.10	16.00

III. RAW MATERIALS CHIEFLY VALUABLE FOR POTASH.

CARBONATE OF POTASH.

This salt contains 68.2 per cent of potash (K_2O), when pure and dry, but commercial grades will contain from 60 to 65 per cent.

Twenty-five samples were examined. One sample was old stock held over from last year and had absorbed a good deal of moisture and another sample, **1433**, was low in potash, probably for the same reason. Sample **1775** was of good grade but somewhat under the guaranty given for it. All other samples were satisfactory, many exceeding 65 per cent. The average of all samples, excluding Nos. **1433** and **999**, is 65.54 per cent. Prices quoted ranged from $6.25 to $6.60 a hundred pounds, at which figures potash in a salt testing 65.5 per cent cost the purchaser from 9.5 to 10 cents a pound.

Analyses are given in Table VII.

MURIATE OF POTASH.

The grades of this material which are used for fertilizer contain from 48 to 50 per cent of actual potash (K_2O), largely as chloride. Chlorides are detrimental to tobacco of the types grown in New England and hence muriate of potash is avoided for tobacco mixtures in this State.

Ten samples were examined and all of them exceeded guaranties. The average of all samples is 50.5 per cent potash and at $52.00 a ton potash costs 5.1 cents a pound.

Analyses are given in Table VII.

SULPHATE OF POTASH.

This salt for fertilizer purposes should contain not less than 48 per cent of potash, and not more than 2.5 per cent of chlorine.[1]

Nineteen samples were analyzed. Most of them met guaranties with substantial averages. Nos. **1196** and **1458** showed shortages in potash approaching 1 per cent. The average potash content found is 49.3 per cent. Prices quoted ranged from $69.00 to $71.00 a ton and averaged $69.50, which makes the cost of potash from this source about seven cents a pound.

SULPHATE OF POTASH-MAGNESIA.

This potash salt was formerly known as "double manure salt," a name which is now practically abandoned. It is a double sulphate

[1] Assoc. of Official Agricultural Chemists, Proc. of October, 1925.

of potash and magnesia containing 25 per cent or more of potash, and is fairly free from chlorine which should not be present in excess of 2.5 per cent.[1]

"*Manure salts*" *is a very different article seldom found in this* State. This material contains 20 to 30 per cent of potash, which is chiefly in the form of chloride.

Only two samples of sulphate of potash-magnesia were analyzed this year. Both satisfied guaranties with substantial overruns.

COTTONHULL ASHES.

This material is extremely variable in composition. Most or all of this fertilizer as sold in this State is screened and remixed by the jobber handling it and some improvement has been secured as regards uniformity. However, different shipments show wide variations, and different portions of the same lot may vary considerably in composition.

Sixty samples of these ashes have been examined this year and the results are given in Table VIII.

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[1] Assoc. of Official Agricultural Chemists, Proc. of October, 1925.

TABLE VII. ANALYSES OF POTASH SALTS, ETC.

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Potash. Found.	Potash. Guaranteed.
	Carbonate of Potash.			
	Sampled by Station.		%	%
1954	Apothecaries Hall Co., Waterbury, Conn.	Sampled at factory	66.24	60.00
1463	Olds & Whipple, Inc., Hartford, Conn.	Sampled at factory	67.49	65.00
	Sampled by Purchaser.			
1181	Apothecaries Hall Co., Waterbury, Conn., Car No. 3683	Hatheway & Steane, Inc., Hartford	61.13	60.00
1182	Apothecaries Hall Co., Waterbury, Conn., Car No. 46112	Hatheway & Steane, Inc., Hartford	64.99	60.00
1183	Apothecaries Hall Co., Waterbury Conn., Truck 1003	Hatheway & Steane, Inc., Hartford	65.10	60.00
1184	Apothecaries Hall Co., Waterbury, Conn., Car No. 48305	Hatheway & Steane, Inc., Hartford	63.87	60.00
1266	Apothecaries Hall Co., Waterbury, Conn., Car No. 400	Hatheway & Steane, Inc., Hartford	63.85	60.00
1659	Apothecaries Hall Co., Waterbury, Conn., Truck 4791	Hatheway & Steane, Inc., Hartford	64.18	60.00
1723	Apothecaries Hall Co., Waterbury, Conn., Car No. 416271	A. N. Shepard & Son, Hartford	63.10	60.00
999	Berkshire Chemical Co., Bridgeport, Conn.	James T. Burgess, Thompsonville	56.43[1]	.....
1228	Harshaw, Fuller & Goodwin, New York, Car No. 16986	American Sumatra Tobacco Co., Bloomfield	66.52	.....
1174	International Agricultural Corp., Atlanta, Ga.	W. S. Pinney, Suffield	66.18	.....
725	A. Klipstein Co., New York, Car No. 44552	American Sumatra Tobacco Co., Bloomfield	66.43	.....
726	A. Klipstein Co., New York, Car No. 165034	American Sumatra Tobacco Co., Bloomfield	65.53	.....
727	A. Klipstein Co., New York, Car No. 62255	American Sumatra Tobacco Co., Bloomfield	67.42	.....
729	A. Klipstein Co., New York, Car No. 342273	American Sumatra Tobacco Co., Bloomfield	66.97	.....
730	A. Klipstein Co., New York, Car No. 415088	American Sumatra Tobacco Co., Bloomfield	66.09	.....

[1]*Moisture, 16.20%. Last year's stock.*

TABLE VII. ANALYSES OF POTASH SALTS, ETC.—*Continued.*

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Potash. Found.	Potash. Guaranteed.
	Carbonate of Potash. *Sampled by Purchaser.*		%	%
893	A. Klipstein Co., New York, Car No. 71236	American Sumatra Tobacco Co., Bloomfield	66.22	.....
894	A. Klipstein Co., New York, Car No. 571483	American Sumatra Tobacco Co., Bloomfield	67.29	.....
1226	A. Klipstein Co., New York, Car No. 23995	American Sumatra Tobacco Co., Bloomfield	65.94	.....
1227	A. Klipstein Co., New York, Car No. 19569	American Sumatra Tobacco Co., Bloomfield	65.56	.....
1229	A. Klipstein Co., New York, Car No. 85658	American Sumatra Tobacco Co., Bloomfield	66.12	.....
1775	Olds & Whipple, Inc., Hartford, Conn., Car N. H. 150075	Silberman & Kahn, Hartford	63.24	65.00
1685	Olds & Whipple, Inc., Hartford, Conn.	Silberman & Kahn, Hartford	60.20	65.00
1433	Manufacturer unknown	P. J. Anderson, Windsor	58.90	.....
	Muriate of Potash. *Sampled by Station.*			
1738	American Agricultural Chemical Co., New York	Sampled at factory, West Haven	51.78	50.00
1413	Apothecaries Hall Co., Waterbury, Conn.	Sampled at factory	51.64	50.00
1565	Armour Fertilizer Works, New York	F. A. Bartlett Tree Expert Co., Stamford	50.50	48.00
1394	Berkshire Chemical Co., Bridgeport, Conn.	Sampled at factory	50.20	50.00
1670	Berkshire Chemical Co., Bridgeport, Conn.	Knowles-Lombard Co., Guilford	50.65	50.00
1370	Consolidated Rendering Co., Boston, Mass.	H. D. Peters, Highwood	51.88	50.00
2158	Eastern States Farmers' Exchange, Springfield, Mass.	F. W. Wooding, North Haven	48.46	48.00
1608	Standard Phosphate & Acid Works, Baltimore, Md.	Julius Lewis, Southington	48.18	48.00

TABLE VII. ANALYSES OF POTASH SALTS, ETC.—*Continued.*

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Potash. Found.	Potash. Guaranteed.
	Muriate of Potash.			
	Sampled by Station.		%	%
1917	I. P. Thomas & Son, Philadelphia, Pa.	J. C. Thompson, Unionville	50.40	50.00
1635	Wilcox Fertilizer Co., Mystic, Conn.	Sampled at factory	51.70	50.00
	Sulphate of Potash.			
	Sampled by Station.			
1734	American Agricultural Chemical Co., New York	E. J. Bantle, Glastonbury	49.59	48.00
1758	Apothecaries Hall Co., Waterbury, Conn.	Sampled at factory	50.72	48.00
2148	Armour Fertilizer Works, New York	James T. Caffrey, Cromwell	49.53	48.00
1393	Berkshire Chemical Co., Bridgeport, Conn.	Sampled at factory	49.05	48.00
1422	Consolidated Rendering Co., Boston, Mass.	L. T. Frisbie Co., New Haven	49.87	48.00
1880	Eastern States Farmers' Exchange, Springfield, Mass.	Frank V. Williams, Buckland	49.46	48.00
1458	Olds & Whipple, Inc., Hartford, Conn.	Sampled at factory	47.80	48.65
	Sampled by Purchaser.			
1185	Apothecaries Hall Co., Waterbury, Conn., Truck 1002	Hatheway & Steane, Inc., Hartford	49.54	48.00
1186	Apothecaries Hall Co., Waterbury, Conn., Car No. 5430	Hatheway & Steane, Inc., Hartford	47.14	48.00
1207	Apothecaries Hall Co., Waterbury, Conn., Car No. 402	Hatheway & Steane, Inc., Hartford	48.33	48.00
1658	Apothecaries Hall Co., Waterbury, Conn., Truck 4791	Hatheway & Steane, Inc., Hartford	48.56	48.00
1727	Apothecaries Hall Co., Waterbury, Conn., Car No. 166056	A. N. Shepard & Son, Hartford	48.98	48.00

TABLE VII. ANALYSES OF POTASH SALTS, ETC.—*Concluded.*

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Potash. Found.	Potash. Guaranteed.
	Sulphate of Potash. *Sampled by Purchaser.*		%	%
997	Berkshire Chemical Co., Bridgeport, Conn.	James T. Burgess, Thompsonville	49.10	48.00
1986	Berkshire Chemical Co., Bridgeport, Conn.	V. L. Hickey, Burnside	49.25	48.00
728	Harshaw, Fuller & Goodwin, New York, Car No. 184770	American Sumatra Tobacco Co., Bloomfield	50.56	.....
2028	Olds & Whipple, Inc., Hartford, Conn.	Lester Lloyd, Suffield	51.33	48.65
1686	Olds & Whipple, Inc., Hartford, Conn.	Silberman & Kahn, Hartford	48.43	48.65
1777	Olds & Whipple, Inc., *Hartford, Conn., Car N. H. 150075*	*Silberman & Kahn, Hartford*	49.60	48.65
1700	Olds & Whipple, Inc., Hartford, Conn.	L. Wetstone & Sons, Hartford	49.73	48.65
	Sulphate of Potash and Magnesia. *Sampled by Station.*			
1408	Apothecaries Hall Co., Waterbury, Conn.	Sampled at factory	27.25	26.00
1968	Eastern States Farmers' Exchange, Springfield, Mass.	Paul W. Caldwell, New Milford	27.71	25.00

TABLE VIII. ANALYSES OF COTTON HULL ASHES.

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Moisture.	Phosphoric Acid.	Potash.
	Sampled by Station.		%	%	%
9852	Ed. Eggert, Hartford, Conn., Car Rock Island 57595 ...	American Agricultural Chemical Co., West Haven ...	15.77	2.55	14.65
9888	Ed. Eggert, Hartford, Conn., Car N. H. 166696 ...	American Agricultural Chemical Co., West Haven ...	18.45	2.57	18.77
9889	Ed. Eggert, Hartford, Conn., Car S. L. S. F. 147205 ...	American Agricultural Chemical Co., West Haven ...	22.45	2.67	15.60
9890	Ed. Eggert, Hartford, Conn., Car A. T. & S. F. 46228 ..	American Agricultural Chemical Co., West Haven ...	19.25	4.77	23.69
303	Ed. Eggert, Hartford, Conn., Lot No. 1 ...	L. B. Haas & Co., Hartford ...	12.13	2.98	31.92
304	Ed. Eggert, Hartford, Conn., Lot No. 2 ...	L. B. Haas & Co., Hartford ...	13.20	4.71	29.13
407	Ed. Eggert, Hartford, Conn. ...	L. B. Haas & Co., Hartford ...	14.33	4.26	27.95
1945	Ed. Eggert, Hartford, Conn. ...	G. A. Peckham, Suffield ...	....	3.14	31.84
1324	Ed. Eggert, Hartford, Conn. ...	J. E. Shepard, So. Windsor ...	....	....	22.34
1322	International Agricultural Corp., Boston, Mass. ...	J. E. Shepard, So. Windsor ...	....	2.44	32.46
1323	International Agricultural Corp., Boston, Mass. ...	J. E. Shepard, So. Windsor ...	....	2.45	32.37
	Sampled by Purchaser.				
2077	F. W. Brode Corp., Memphis, Tenn., Car No. 37614 ...	The Otee Tobacco Corp., Hartford ...	....	2.65	21.18
2114	F. W. Brode Corp., Memphis, Tenn., Car No. 128835 ..	The Otee Tobacco Corp., Hartford ...	....	2.73	31.15
2115	F. W. Brode Corp., Memphis, Tenn., Car No. 28161 ...	The Otee Tobacco Corp., Hartford ...	....	1.83	15.47
2139	F. W. Brode Corp., Memphis, Tenn., Car No. 46481 ...	The Otee Tobacco Corp., Hartford ...	....	3.65	25.95
2112	F. W. Brode Corp., Memphis, Tenn., Car No. 156794 ..	J. B. Stewart, Windsor ...	....	2.94	27.04

TABLE VIII. ANALYSES OF COTTON HULL ASHES—*Continued.*

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Moisture.	Phosphoric Acid.	Potash.
	Sampled by Purchaser.		%	%	%
2113	F. W. Brode Corp., Memphis, Tenn., Car No. 204733	J. B. Stewart, Windsor	.....	3.64	19.65
2117	F. W. Brode Corp., Memphis, Tenn., Car No. 43268	J. B. Stewart, Windsor	.....	3.12[1]	20.36
1679	Ed. Eggert, Hartford, Conn., Car No. 46021	American Sumatra Tobacco Co., Bloomfield	.....	3.45	25.00
408	Ed. Eggert, Hartford, Conn., Car C. M. & St. Paul 711241	P. J. Anderson, Windsor	14.98	2.93	12.03
409	Ed. Eggert, Hartford, Conn., Car C. M. & St. Paul 711241	P. J. Anderson, Windsor	3.22	1.47	3.68
461	Ed. Eggert, Hartford, Conn., Car S. F. 148880	P. J. Anderson, Windsor	6.48	....	34.98
635	Ed. Eggert, Hartford, Conn., Car St. L. 129233	P. J. Anderson, Windsor	.....	....	36.14
636	Ed. Eggert, Hartford, Conn., Car R. I. 133611	P. J. Anderson, Windsor	.....	....	35.74
637	Ed. Eggert, Hartford, Conn., Car C. R. I. & P. 156134	P. J. Anderson, Windsor	.....	....	37.34
638	Ed. Eggert, Hartford, Conn., Car R. I. 57845	P. J. Anderson, Windsor	.....	....	32.60
639	Ed. Eggert, Hartford, Conn., Car St. L. 161328	P. J. Anderson, Windsor	.....	....	31.45
640	Ed. Eggert, Hartford, Conn., Car Frisco 122879	P. J. Anderson, Windsor	.....	....	37.42
693	Ed. Eggert, Hartford, Conn., Car R. I. 350135	Edwards & Brewer, Hartford	8.75	3.51	25.08
694	Ed. Eggert, Hartford, Conn., Car R. I. 350228	Edwards & Brewer, Hartford	12.08	4.45	28.58
695	Ed. Eggert, Hartford, Conn., Car S. L. & S. F. 129344	Edwards & Brewer, Hartford	10.71	3.48	28.04
696	Ed. Eggert, Hartford, Conn., Car S. L. & S. F. 128712	Edwards & Brewer, Hartford	12.05	4.20	27.64
993	Ed. Eggert, Hartford, Conn., Car M. O. P. 31613	Edwards & Brewer, Hartford	.....	2.97	22.52
1240	Ed. Eggert, Hartford, Conn., Car R. I. 46687	Edwards & Brewer, Hartford	.....	3.52	23.62
1241	Ed. Eggert, Hartford, Conn., Car R. I. 46687	Edwards & Brewer, Hartford	.....	2.68	21.54

[1] Moisture 14.4%.

TABLE VIII. ANALYSES OF COTTON HULL ASHES—*Continued.*

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Moisture.	Phosphoric Acid.	Potash.
	Sampled by Purchaser.		%	%	%
1596	Ed. Eggert, Hartford, Conn., Car H. 46687	Edwards & Brewer, Hartford	.....	2.33	33.98
1597	Ed. Eggert, Hartford, Conn., Car S. L. & S. F. 122837	Edwards & Brewer, Hartford	.....	3.23	24.78
1753	Ed. Eggert, Hartford, Conn., Car CRIP 3299	Edwards & Brewer, Hartford	.....	3.38	25.39
2023	Ed. Eggert, Hartford, Conn., Lot XX	Edwards & Brewer, Hartford	.....	2.95	33.08
2024	Ed. Eggert, Hartford, Conn., Lot No. 100	Edwards & Brewer, Hartford	.....	4.20	21.65
229	Ed. Eggert, Hartford, Conn., Car No. R. I. 350228	Ed. Eggert, Hartford	12.65	4.24	27.84
230	Ed. Eggert, Hartford, Conn., Car No. St. L. & S. F. 128712	Ed. Eggert, Hartford	10.03	4.06	28.08
231	Ed. Eggert, Hartford, Conn., Car No. 31613	Ed. Eggert, Hartford	9.78	3.19	22.74
747	Ed. Eggert, Hartford, Conn., Lot No. 8	Ed. Eggert, Hartford	.....	2.59	32.04
953	Ed. Eggert, Hartford, Conn., Truck 5430	Hatheway & Steane, Inc., Hartford	.....	4.27	25.20
1176	Ed. Eggert, Hartford, Conn., Truck No. 3	Hatheway & Steane, Inc., Hartford	.....	4.18	26.94
1177	Ed. Eggert, Hartford, Conn., Car No. 37-989	Hatheway & Steane, Inc., Hartford	.....	4.26	28.25
1624	Ed. Eggert, Hartford, Conn., Car 5-203	Hatheway & Steane, Inc., Hartford	.....	4.20	25.58
1726	Ed. Eggert, Hartford, Conn.	A. N. Shepard & Son, Hartford	.....	2.24	28.51
2040	Ed. Eggert, Hartford, Conn.	A. N. Shepard & Son, Hartford	.....	2.08	27.50
1485	Ed. Eggert, Hartford, Conn.	J. E. Shepard, So. Windsor	.....	4.48	22.17
1486	Ed. Eggert, Hartford, Conn.	J. E. Shepard, So. Windsor	.....	4.38	22.05
1771	Ed. Eggert, Hartford, Conn.	Spencer Bros., Inc., Suffield	.....	3.41	12.89
994	International Agricultural Corp., Boston, Mass. Car D. & H. 20826	J. E. Shepard, So. Windsor	.....	2.88	33.66

TABLE VIII. ANALYSES OF COTTON HULL ASHES—*Concluded.*

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Moisture.	Phosphoric Acid.	Potash.
	Sampled by Purchaser.		%	%	%
995	International Agricultural Corp., Boston, Mass., Car B. & M. 68094	J. E. Shepard, So. Windsor	.....	2.76	36.34
1701	Olds & Whipple, Inc., Hartford, Conn., Car No. 169164	L. Wetstone & Sons, Hartford	.....	2.38	23.09
2016	Ed. Eggert, Hartford, Conn., Car S. L. & S. F. 121723[1]	Edwards & Brewer, Hartford	.....	1.30	8.35
2017	Ed. Eggert, Hartford, Conn., Car S. F. 147051[1]	Edwards & Brewer, Hartford	.....	1.75	8.35
2004	Manufacturer unknown	Meyer & Mendelsohn, Inc., Hartford	.....	3.38	17.79
820	Manufacturer unknown	American Sumatra Tobacco Co., Bloomfield	.....	2.32	40.16

[1] Bought for low grade ashes.

IV. RAW MATERIALS CONTAINING NITROGEN AND POTASH.

NITRATE OF POTASH AND NITRATE OF POTASH-SODA.

Potassium nitrate (salt peter), occurs naturally in small deposits in various parts of the world. It is also manufactured from nitrate of soda and muriate of potash. The salt should contain not less than 12 per cent of nitrogen and not less than 44 per cent of potash.

Nitrate of soda-potash is a mixture of about ¾ nitrate of soda and ¼ nitrate of potash. It occurs in Chile and yields about 14 per cent of nitrogen and 10 per cent or more of potash.

Both of these salts are used to some extent in mixtures for tobacco. Eight samples of potassium nitrate and three of nitrate of potash-soda were examined this year. All were of good grade and fully met guaranties in both elements of plant food.

Analyses are given in Table IX.

TABLE IX. ANALYSES OF NITRATE OF POTASH, ETC.

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Nitrogen. Found.	Nitrogen. Guaranteed.	Equivalent to Ammonia. Found.	Equivalent to Ammonia. Guaranteed.	Potash. Found.	Potash. Guaranteed.
	Nitrate of Potash. *Sampled by Station.*							
1969	Eastern States Farmers' Exchange, Springfield, Mass.	Paul W. Caldwell, New Milford	% 13.24	% 13.00	% 16.10	% 15.79	% 44.31	% 44.00
1459	Olds & Whipple, Inc., Hartford	Sampled at factory	13.28	12.55	16.15	15.00	45.65	44.00
1903	Synthetic Nitrogen Products Co., New York	John Richards, So. Glastonbury	13.28	13.00	16.15	15.70	44.50	44.00
	Sampled by Purchaser.							
1329	Berkshire Chemical Co., Bridgeport, Conn., Car N. H. 171354	*Cullman Bros., Hartford*	14.22	.....	17.29	.....	43.09	.....
1892	Eastern States Farmers' Exchange, Springfield, Mass.	Donald J. Grant, Buckland	14.16	13.00	17.22	15.79	46.43	44.00
919	Olds & Whipple, Inc., Hartford	Huntington Bros., Windsor	13.16	12.55	16.00	15.00	45.81	44.00
1684	Olds & Whipple, Inc., Hartford	Silberman & Kahn, Hartford	13.26	12.55	16.12	15.00	45.40	44.00
1776	Olds & Whipple, Inc., Hartford	Silberman & Kahn, Hartford	13.16	12.55	16.00	15.00	45.61	44.00
	Nitrate of Soda and Potash. *Sampled by Station.*							
1411	Apothecaries Hall Co., Waterbury	Sampled at factory	14.86	14.80	18.07	18.00	14.55	10.00
988	W. R. Grace & Co., New York Car No. 65037	L. B. Haas & Co., Hartford	14.40	.....	17.51	.....	16.55	.....
1992	Wilcox Fertilizer Co., Mystic	J. R. Haley, Groton	15.06	14.80	18.31	18.00	12.25	12.00

V. RAW MATERIAL CONTAINING NITROGEN AND PHOSPHORIC ACID.

DRY GROUND FISH.

Dry ground fish, also known as fish scrap and fish tankage, is made from non-edible fish and offal from fish canneries. Oil is removed by steaming and pressing and the residue is then dried and ground. Fish may also be acidulated to prevent decomposition.

Fish scrap is generally sold on a guaranty of 8.20 per cent of nitrogen and 5 to 6 per cent of phosphoric acid. The nitrogen is organic and fairly valued at 45 to 47 cents a pound this year.

Last year a considerable quantity of fish scrap, in which inorganic nitrogen was largely substituted for fish nitrogen, came into this State. Examination of all samples this year has failed to show any evidence of adulteration of this sort. Although microscopically a number of samples were found to contain crystals of ammonium sulphate, the amounts did not appear to be considerable, and determinations of ammonia nitrogen did not show significant quantities. In two samples considerably decomposed, somewhat more than 1 per cent of nitrogen as ammonia was found, but no evidence of ammonium sulphate was found by microscopic examination. We have not found ammonium sulphate this year in any quantity which could not reasonably be explained on the basis of accidental contamination.

Another substance which we have noted in a considerable number of cases is superphosphate. The explanation given us is that the nitrogen content of fish is sometimes standardized by means of the addition of superphosphate. While it might be argued that a mixture of dry ground fish and superphosphate is not dry ground fish, nevertheless such an addition does not lessen the value of the material provided the nitrogen guaranty is met. The almost uniform guaranty of 8.22 per cent nitrogen suggests that the product is standardized by some means. There appeared to be no excessive amounts of superphosphate in the samples examined and moreover those samples showing deficiencies in nitrogen were not always identical with those containing superphosphate. In some cases samples showing less than the guaranteed amount of nitrogen showed no evidence of superphosphate; and in other cases where superphosphate was present the nitrogen found was considerable above that guaranteed.

Thirty-eight samples were examined this year. If we accept 47 cents a pound as a fair valuation for the nitrogen in fish, then commercial deficiencies greater than $1.00 a ton (equivalent to a shortage of 0.11 per cent in nitrogen), are shown in samples **1259, 1878, 1257** and **987**. Four other samples submitted without guar-

anties are also considerably deficient if the usual guaranty of 8.22 per cent nitrogen is assumed. In these calculations overages, if any, in phosphoric acid are not considered.

Analyses are given in Table X.

TANKAGE.

This raw material is derived from refuse meat and bone. The refuse is treated with steam and then pressed to remove fat, after which the residue is dried and ground.

The composition of tankage with respect to nitrogen and phosphoric acid will depend upon the nature of the material; if meat predominates, nitrogen will be high and phosphoric acid relatively low, while the reverse will be true if there is a considerable excess of bone present.

Of the eleven samples examined this year Nos. 1407 and 1424 are essentially bone tankages as indicated by both analyses and guaranties. Four samples, 1760, 1972, 1607 and 1996 were considerably deficient in nitrogen. Of these, 1760 1972 and 1607 also were low in phosphoric acid.

Analyses are given in Table XI.

GROUND BONE.

Raw bone meal or raw ground bone is the product made by drying and grinding animal bones which have not been previously steamed under pressure.

Steamed bone meal or steamed ground bone is the product made by steaming bones under pressure, after which they are dried and ground.

Steamed bone will contain considerably less nitrogen than raw bone.

Thirty-five samples were examined and so far as guaranties were given, there were only two deficiencies in nitrogen and two in phosphoric acid. The nitrogen shortages were both less than 0.2 per cent and, in general, the character of this material this year was very satisfactory. Last year a number of samples of bone were found to contain notable quantities of inorganic ammoniates, or mineral phosphates, or both, but in only four samples this year was any evidence of these materials found and in no case were the amounts considerable.

Analyses are given in Table XII.

TABLE X. ANALYSES OF DRY GROUND FISH.

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Nitrogen		Ammonia equivalent to total nitrogen.	Phosphoric Acid.		Station No.
			Total found.	Total guaranteed.		Total found.	Total guaranteed.	
	Sampled by Station.		%	%	%	%	%	
1499	American Agricultural Chemical Co., New York City	F. S. Bidwell Co., Windsor Locks	8.12	8.23	9.87	18.55	6.00	1499
1957	Apothecaries Hall Co., Waterbury	Jos. P. Norton, Broad Brook	9.61	8.20	11.68	6.26	5.00	1957
1259	Berkshire Chemical Co., Bridgeport	L. B. Haas & Co., Hartford	7.86	8.22	9.56	6.77	6.00	1259
1878	Eastern States Farmers' Exchange, Springfield, Mass.	Frank V. Williams, Buckland	7.39	9.00	8.98	6.91	6.90	1878
1468	Olds & Whipple, Inc., Hartford	Sampled at factory	9.28	8.23	11.28	7.65	5.00	1468
1610	Standard Phosphate & Acid Works, Baltimore, Md.	E. O. Chapman, No. Haven	8.66	8.22	10.53	6.68	6.00	1610
1257	Wilcox Fertilizer Co., Mystic	J. E. Shepard, So. Windsor	8.03	8.23	9.76	6.67	6.00	1257
	Sampled by Purchaser.							
821	Apothecaries Hall Co., Waterbury	Hatheway & Steane, Inc., Hartford	9.73	8.20	11.83	6.66	5.00	821
858	Apothecaries Hall Co., Waterbury	Hatheway & Steane, Inc., Hartford	9.86	8.20	11.99	7.46	5.00	858
859	Apothecaries Hall Co., Waterbury	Hatheway & Steane, Inc., Hartford	9.94	8.20	12.09	7.16	5.00	859
1270	Apothecaries Hall Co., Waterbury	Hatheway & Steane, Inc., Hartford	10.03	8.20	12.19	6.76	5.00	1270
1656	Apothecaries Hall Co., Waterbury	Hatheway & Steane, Inc., Hartford	9.19	8.20	11.17	6.71	5.00	1656
1261	Apothecaries Hall Co., Waterbury	Hatheway & Steane, Inc., Hartford	9.92	8.20	12.06	7.41	5.00	1261
1725	Apothecaries Hall Co., Waterbury	A. N. Shepard & Son, Hartford	9.18	8.20	11.16	6.98	5.00	1725

TABLE X. ANALYSES OF DRY GROUND FISH—*Continued.*

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Nitrogen.		Ammonia equivalent to total nitrogen.	Phosphoric Acid.		Station No.
			Total found.	Total guaranteed.		Total found.	Total guaranteed.	
	Sampled by Purchaser.		%	%	%	%	%	
737	Berkshire Chemical Co., Bridgeport	American Sumatra Tobacco Co., Bloomfield	7.80	8.22	9.48	6.80	6.00	737
738	Berkshire Chemical Co., Bridgeport	American Sumatra Tobacco Co., Bloomfield	8.70	8.22	10.58	7.11	6.00	738
739	Berkshire Chemical Co., Bridgeport	American Sumatra Tobacco Co., Bloomfield	8.26	8.22	10.04	6.76	6.00	739
740	Berkshire Chemical Co., Bridgeport	American Sumatra Tobacco Co., Bloomfield	8.13	8.22	9.88	6.88	6.00	740
741	Berkshire Chemical Co., Bridgeport	American Sumatra Tobacco Co., Bloomfield	7.96	8.22	9.68	7.16	6.00	741
758	Berkshire Chemical Co., Bridgeport	American Sumatra Tobacco Co., Bloomfield	7.97	8.22	9.69	6.95	6.00	758
759	Berkshire Chemical Co., Bridgeport	American Sumatra Tobacco Co., Bloomfield	8.22	8.22	9.99	7.14	6.00	759
760	Berkshire Chemical Co., Bridgeport	American Sumatra Tobacco Co., Bloomfield	8.17	8.22	9.93	6.37	6.00	760
761	Berkshire Chemical Co., Bridgeport	American Sumatra Tobacco Co., Bloomfield	8.67	8.22	10.54	6.84	6.00	761
762	Berkshire Chemical Co., Bridgeport	American Sumatra Tobacco Co., Bloomfield	8.54	8.22	10.38	6.02	6.00	762

TABLE X. ANALYSES OF DRY GROUND FISH—*Concluded.*

Station No.	Manufacturer or Wholesale Dealer.	Dealer or Purchaser.	Nitrogen.		Ammonia equivalent to total nitrogen.	Phosphoric Acid.		Station No.
			Total found.	Total guaranteed.		Total found.	Total guaranteed.	
	Sampled by Purchaser.		%	%	%	%	%	
996	Berkshire Chemical Co., Bridgeport	James T. Burgess, Thompsonville	8.63	8.22	10.49	5.96	6.00	996
880	Berkshire Chemical Co., Bridgeport	Cullman Bros., Hartford	9.46	8.22	11.50	7.60	6.00	880
1030	Berkshire Chemical Co., Bridgeport	Cullman Bros., Hartford	9.42	9.46	11.45	7.11	6.00	1030
1031	Berkshire Chemical Co., Bridgeport	Cullman Bros., Hartford	9.40	9.46	11.43	7.18	6.00	1031
987	Berkshire Chemical Co., Bridgeport	L. B. Haas & Co., Inc., Hartford	8.02	8.22	9.75	6.44	6.00	987
1342	Berkshire Chemical Co., Bridgeport	L. B. Haas & Co., Inc., Hartford	8.72	8.22	10.60	6.39	6.00	1342
921	Olds & Whipple, Inc., Hartford	Huntington Bros., Windsor	8.65	8.23	10.52	6.30	5.00	921
1689	Olds & Whipple, Inc., Hartford	Silberman & Kahn, Hartford	9.74	8.23	11.84	8.00	5.00	1689
1781	Olds & Whipple, Inc., Hartford	Silberman & Kahn, Hartford	9.68	8.23	11.77	7.85	5.00	1781
1705	Olds & Whipple, Inc., Hartford	L. Wetstone & Sons, Hartford	8.62	8.23	10.48	8.25	5.00	1705
1706	Olds & Whipple, Inc., Hartford	L. Wetstone & Sons, Hartford	8.14	8.23	9.90	8.23	5.00	1706
1891	Wilcox Fertilizer Co., Mystic	V. L. Hickey, Burnside	8.19	8.22	9.96	7.30	6.00	1891
899	Wilcox Fertilizer Co., Mystic	J. E. Shepard, So. Windsor	8.29	8.22	10.08	6.72	6.00	899
900	Wilcox Fertilizer Co., Mystic	J. E. Shepard, So. Windsor	8.05	8.22	9.79	7.21	6.00	900

TABLE XI. ANALYSES OF TANKAGE.

Station N	Manufacturer.	Dealer or Purchaser.	Nitrogen. Total found.	Nitrogen. Total guaranteed.	Ammonia equivalent to total nitrogen.	Phosphoric Acid. Total found.	Phosphoric Acid. Total guaranteed.	Mechanical Analysis. Finer than 1-50 inch.	Mechanical Analysis. Coarser than 1-50 inch.	Station No.
	Sampled by Station.		%	%	%	%	%	%	%	
1407	Apothecaries Hall Co., Waterbury ..	J. A. Glasnapp, West Cheshire ..	3.75	3.29	4.56	20.60	20.00	53.5	46.5	1407
1569	Apothecaries Hall Co., Waterbury ..	J. B. McArdle, Greenwich	7.48	7.40	9.09	11.45	3.00	43.5	56.5	1569
1760	Armour Fertilizer Works, New York City	A. R. Jones, Wallingford	6.94	7.40	8.44	5.59	6.87	38.0	62.0	760
1372	Berkshire Chemical Co., Bridgeport..	J. A. Smith, Hamden	7.76	7.40	9.43	7.65	6.86	40.5	59.5	1372
1424	Conn. Fat Rendering & Fertilizer Corp., New Haven	Sampled at factory	3.60	3.29	4.38	21.80	.....	41.0	59.0	1424
1371	Consolidated Rendering Co., Boston, Mass.	H. D. Peters, Highwood	7.84	7.41	9.53	10.64	9.15	33.0	67.0	1371
1421	Consolidated Rendering Co., Boston, Mass.	L. T. Frisbie Co., New Haven ..	5.18	4.92	6.30	16.14	14.00	35.5	64.5	1421
1972	Eastern States Farmers' Exchange Springfield, Mass.	Harold Brundage, Danbury	7.18	7.50	8.73	8.75	9.20	34.0	66.0	1972
1396	Standard Phosphate & Acid Works, Baltimore, Md.	Geo. S Jennings, Southport	7.46	7.40	9.07	4.98	.....	26.5	73.5	1396
1607	Standard Phosphate & Acid Works, Baltimore, Md.	*Julius Lewis, Southington*	6.60	7.40	8.02	7.78	9.15	29.5	70.5	1607
1996	Standard Phosphate & Acid Works, Baltimore, Md.	Rand & Christensen, Wilson	7.88	8.22	9.58	4.66	4.57	25.5	74.5	1996

TABLE XII. ANALYSES OF GROUND BONE.

Station No.	Manufacturer.	Dealer or Purchaser.	Nitrogen. Total found.	Nitrogen. Total guaranteed.	Ammonia equivalent to total nitrogen.	Phosphoric Acid. Total found.	Phosphoric Acid. Total guaranteed.	Mechanical Analysis. Finer than 1-50 inch.	Mechanical Analysis. Coarser than 1-50 inch.	Station No.
	Sampled by Station.		%	%	%	%	%	%	%	
1390	American Agricultural Chemical Co., New York City	S. P. Strople, New Britain	2.48	2.47	3.02	25.95	22.88	43.5	56.5	1390
1412	Apothecaries Hall Co., Waterbury	Sampled at factory	3.64	3.29	4.43	23.25	20.00	50.5	49.5	1412
1447	Apothecaries Hall Co., Waterbury	Templeton Hardware Co., Waterbury	2.78	2.46	3.38	24.18	22.00	59.0	41.0	1447
1562	Armour Fertilizer Works, New York City	Raven's Hardware Co., Meriden	2.51	2.47	3.05	23.45	22.00	65.5	34.5	1562
1395	Berkshire Chemical Co., Bridgeport	C. Buckingham & Co., Southport	1.95	2.06	2.37	26.85	23.00	50.5	49.5	1395
1420	Consolidated Rendering Co., Boston, Mass.	Lightbourn & Pond Co., New Haven	3.86	2.46	4.69	21.18	22.90	33.0	67.0	1420
1962	Eastern States Farmers' Exchange Springfield, Mass.	Hoyt's Nurseries, New Canaan	2.59	2.50	3.15	26.60	23.00	59.5	40.5	1962
1467	Olds & Whipple, Inc., Hartford	Rackliffe Bros. Co., New Britain	2.84	2.50	3.45	22.80	22.00	61.5	38.5	1467
1901	Olds & Whipple, Inc., Hartford	John Richards, So. Glastonbury	2.74	2.50	3.33	24.42	22.00	60.5	39.5	1901
1537	The Rogers & Hubbard Co., Portland	Cadwell & Jones, Hartford	3.45	3.29	4.19	20.00	20.50	52.0	48.0	1537
1538	The Rogers & Hubbard Co., Portland	Cadwell & Jones, Hartford	3.52	3.69	4.28	26.60	24.70	70.5	29.5	1538
1923	The Rogers & Hubbard Co., Portland	Sampled at factory	3.86	3.69	4.69	25.85	24.70	73.0	27.0	1923
1644	M. L. Shoemaker & Co., Philadelphia, Pa.	Geo. T. Soule Co., New Milford	4.00	3.69	4.86	21.58	21.51	34.0	66.0	1644

TABLE XII. ANALYSES OF GROUND BONE—*Continued.*

Station No.	Manufacturer.	Dealer or Purchaser.	Nitrogen. Total found.	Nitrogen. Total guaranteed.	Ammonia equivalent to total nitrogen.	Phosphoric Acid. Total found.	Phosphoric Acid. Total guaranteed.	Mechanical Analysis. Finer than 1–50 *inch.*	Mechanical Analysis. Coarser than 1–50 inch.	Station No.
	Sampled by Station.		%	%	%	%	%	%	%	
1601	Standard Phosphate & Acid Works, Baltimore, Md.	Eldridge Hardware Co., Norwich	3.39	2.47	4.12	26.97	22.00	31.5	68.5	**1601**
2001	Standard Phosphate & Acid Works, Baltimore, Md.	Morris L. Burr, Southport	3.42	3.30	4.16	25.67	18.30	30.5	69.5	**2001**
1631	Virginia-Carolina Chemical Co., New York City	Stanley Svea Coal Co., New Britain	2.52	2.47	3.06	22.50	22.50	69.5	30.5	**1631**
1616	I. P. Thomas & Son, Philadelphia, Pa.	W. S. Eaton, Plainville	2.49	2.45	3.03	23.40	23.00	59.5	40.5	**1616**
1642	Wilcox Fertilizer Co., Mystic	Sampled at factory	2.68	2.46	3.26	25.35	22.00	77.0	23.0	**1642**
	Sampled by Purchaser.									
860	Apothecaries Hall Co., Waterbury	Hatheway & Steane, Inc., Hartford	4.39	....	5.34	21.86	.....	....	....	**860**
1215	Apothecaries Hall Co., Waterbury, Car No. 161901	Hatheway & Steane, Inc., Hartford	2.99	....	3.64	26.00	.....	....	....	**1215**
1263	Apothecaries Hall Co., Waterbury, Car No. 405	Hatheway & Steane, Inc., Hartford	4.00	3.29	4.86	21.50	20.00	41.8	58.2	**1263**
1264	Apothecaries Hall Co., Waterbury, Car No. 81547	Hatheway & Steane, Inc., Hartford	4.39	....	5.34	22.16	.....	60.4	39.6	**1264**

TABLE XII. ANALYSES OF GROUND BONE—*Continued.*

Station No.	Manufacturer.	Dealer or Purchaser.	Nitrogen. Total found.	Nitrogen. Total guaranteed.	Ammonia equivalent to total nitrogen.	Phosphoric Acid. Total found.	Phosphoric Acid. Total guaranteed.	Mechanical Analysis. Finer than 1–50 inch.	Mechanical Analysis. Coarser than 1–50 inch.	Station No.
	Sampled by Purchaser.		%	%	%	%	%	%	%	
1265	Apothecaries Hall Co., Waterbury, Car No. 168414	Hatheway & Steane, Inc., Hartford	5.05	....	6.14	19.76	....	31.9	68.1	1265
1660	Apothecaries Hall Co., Waterbury, Truck 4791	Hatheway & Steane, Inc., Hartford	4.23	....	5.14	22.14	....	63.2	36.8	1660
1724	Apothecaries Hall Co., Waterbury, Car No. 169078	A. N. Shepard & Son, Hartford	3.74	....	4.55	21.22	....	39.5	60.5	1724
1000	Berkshire Fertilizer Co., Bridgeport	James T. Burgess, Thompsonville	2.21	2.06	2.69	28.12	23.00	....	....	1000
1773	L. T. Frisbie Co., New Haven	Allen H. Treat, Hudson, N. Y.	3.76	....	4.57	22.90	....	....	....	1773
657	Harshaw, Fuller, Goodwin Co., New York, Car No. 163619	American Sumatra Tobacco Co., Bloomfield	2.75	....	3.34	24.84	....	....	....	657
658	Harshaw, Fuller, Goodwin Co., New York, Car No. 160305	American Sumatra Tobacco Co., Bloomfield	2.89	....	3.51	24.98	....	....	....	658
685	Harshaw, Fuller, Goodwin Co., New York, Car No. 425345	American Sumatra Tobacco Co., Bloomfield	2.64	....	3.21	25.94	....	....	....	685
686	Harshaw, Fuller, Goodwin Co., New York, Car No. 78208	American Sumatra Tobacco Co., Bloomfield	2.66	....	3.23	25.08	....	....	....	686
764	Harshaw, Fuller, Goodwin Co., New York, Car No. 23344	American Sumatra Tobacco Co., Bloomfield	2.79	....	3.39	25.56	....	....	....	764

TABLE XII. ANALYSES OF GROUND BONE—*Concluded.*

Station No.	Manufacturer.	Dealer or Purchaser.	Nitrogen.		Ammonia equivalent to total nitrogen.	Phosphoric Acid.		Mechanical Analysis.		Station No.
			Total found.	Total guaranteed.		*Total found.*	Total guaranteed.	Finer than 1–50 inch.	Coarser than 1–50 inch.	
	Sampled by Purchaser.		%	%	%	%	%	%	%	
765	Harshaw, Fuller, Goodwin Co., New York, Car No. 3989	American Sumatra Tobacco Co., Bloomfield	3.15	....	3.83	25.02	.....	....	....	765
891	Harshaw, Fuller, Goodwin Co., New York, Car No. 12199	American Sumatra Tobacco Co., Bloomfield	2.78	....	3.38	27.22	.....	....	....	891
892	Harshaw, Fuller, Goodwin Co., New York, Car No. 11165	American Sumatra Tobacco Co., Bloomfield	2.83	....	3.44	26.22	.....	....	....	892

VI. MIXED FERTILIZERS.

MIXTURES CONTAINING ONLY NITROGEN AND PHOSPHORIC ACID.

Five samples of this group of materials were analyzed.

1875. Lawn Fertilizer. Apothecaries Hall Co., Waterbury. Sampled by Station agent from stock of Yantic Grain & Products Co., Norwich, Conn.

1952. Tobacco Starter. Apothecaries Hall Co., Waterbury. Sampled by Station agent at factory.

1980. O & W High Grade Tobacco Starter. Olds & Whipple, Inc., Hartford. Sampled by Station agent from stock of Julius Ident, South Windsor, Conn.

1995. *Milorganite.* Sewerage Commission, Milwaukee, Wis. Sampled by Station agent from stock of T. S. Griswold, West Hartford, Conn.

1665. Swift-Sure Tobacco Starter. M. L. Shoemaker & Co., Philadelphia, Pa. Sampled by Station agent from stock of A. D. Bridge's Sons, Hazardville, Conn.

	1875	1952	1980	1995	1665
	%	%	%	%	%
Nitrogen, found	4.16	3.81	8.11	4.94	3.25
guaranteed	3.29	3.29	8.23	5.00	3.28
Ammonia, equivalent to nitrogen	5.06	4.63	9.86	6.01	3.95
Phosphoric acid, total	11.50	10.88	5.16	2.40	10.93
available found	6.82	9.65	4.14	2.05	10.53
guaranteed	4.00	10.00	3.00	2.00	10.00

MIXTURES CONTAINING ONLY PHOSPHORIC ACID AND POTASH.

Only two samples of this group were analyzed.

2160. Eastern States Open Formula 0-14-6. Eastern States Farmers' Exchange, Springfield, Mass. Sampled by Station agent from stock of H. H. McKnight, Ellington.

It contained 14.83 per cent total and 14.32 per cent available phosphoric acid, and 6.38 per cent of potash.

2224. Dairymen's Special, 0-10-10. I. P. Thomas & Son, Philadelphia. Sampled from stock of H. A. Costello, Mgr., Simsbury.

It contained 10.11 per cent of available phosphoric acid and 10.05 per cent of potash.

MIXTURES CONTAINING ONLY NITROGEN AND POTASH.

2049. Special Tobacco Formula, 9-0-7. Old Deerfield Fertilizer Co., South Deerfield, Mass.

It contained 7.28 per cent of nitrogen (equivalent to 8.85 per

cent of ammonia), 1.85 per cent of available phosphoric acid and 8.08 per cent of potash. It was somewhat deficient in ammonia and contained about 2 per cent of phosphoric acid, although none was guaranteed.

MIXTURES CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH.

In this group there are 239 official samples and 9 which were sampled by purchasers, a total of 248. Analyses are given in Table XIII. The following tabulated statement summarizes the results of the inspection.

Total number of official samples analyzed		239
Samples considerably deficient in		
one item	61	
two items	5	
three items	0	66
Total items of plant food guaranteed (239 x 3)		717
Total items found deficient:		
ammonia	21	
available phosphoric acid	25	
potash	25	71
Total guaranties substantially met or exceeded		646
Per cent of guaranties substantially met or exceeded		90
Samples showing approximate commercial deficiencies exceeding $1.00 per ton		9

Deficient Samples.

The number of samples found to be substantially below guaranties in one or more items of plant food is less than for several years past. In considering deficiencies those shortages which are within the limits of reasonable analytical variation have been disregarded. Very few of the samples were short in more than one of the guaranteed constituents; and the most expensive element of plant food (nitrogen) showed the fewest deficiencies.

In estimating the approximate value represented by the shortages found, it is our practice to balance such shortages against any overages found. This plan may be open to the objection that a purchaser who, for example, receives less nitrogen than is guaranteed him is not properly compensated by receiving an extra supply of phosphoric acid, or of potash, or of both. However, we are attempting to arrive at a balance of commercial values and not of agricultural values and, moreover, it is not clear that measurable effects of the shortages and overages of such magnitudes as are generally involved in the case of mixed fertilizers can be noted in the field. In the instance of certain raw materials, fish for example, which is purchased chiefly for its nitrogen, the consideration may be somewhat different.

The number of samples showing commercial deficiencies in excess of $1.00 a ton is nine this year, or less than 4 per cent of the total number of official samples examined. In computing these values ammonia has been reckoned at 20 cents a pound, available phosphoric acid at 5½ cents, and potash at 5 cents. Similar data compiled for a nine-year period shows that of more than 2,000 samples examined, 93 per cent of them have substantially equalled or exceeded commercial values as represented by guaranties: and for the past year the corresponding percentage is 96.

The distribution of deficiencies and the summary of commercial deficiencies are given in Tables XIV, XV and XVI.

Grades and Guaranties.

In recent years, there has been an increasing practice of branding mixed fertilizers to show the percentages of plant food which they contain, such percentages being given generally in whole numbers, for example 4-8-4, and representing in the Northeastern States ammonia, available phosphoric acid and potash in the order named. This order does not prevail in all sections of the country, however, the chief variation from it being that available phosphoric is sometimes stated first. Thus using the above example, the statement would be 8-4-4. For some time there has been an effort made to have designations of grade made in a uniform manner and the Association of Official Agricultural Chemists has approved of the statement of grade giving the nitrogenous element first and giving it in terms of nitrogen instead of ammonia. The American Fertilizer Association agrees to this plan as do also agronomists who have, in fact, been largely responsible for the reversion to the plan of stating nitrogenous constituents in terms of the element nitrogen.

There has been very little inclination on the part of manufacturers to adopt the new plan this year. Of all the firms registering mixed fertilizers in this State all but three have adhered to the old plan. It is gratifying to observe that where the new plan has been followed nitrogen has been stated in whole numbers, allowing the fractions to fall on the ammonia equivalent.

In Table XIII, which gives analyses of mixed fertilizers, the column headed "grade" has the usual significance, that is, the first figure denotes ammonia. The few departures from this plan are indicated by foot notes.

Quality of the Organic Nitrogen.

The usual laboratory methods for evaluating the activity of the insoluble organic nitrogen in fertilizer materials indicated organic ammoniates of inferior character in only two instances. In one

of these, however, the water soluble nitrogen practically equalled the total nitrogen guaranteed and the sample was passed, without question. In the other, **1845**, Standard Wholesale Acid and Phosphate Works 5-4-5, the total nitrogen found was much short of the guaranty and the activity of the insoluble organic-nitrogen was found to be 31.6 per cent by the alkaline method and 59.4 per cent by the neutral method. Values of less than 50 and 80 by these respective methods are taken to indicate the presence of ammoniates of inferior quality.

TABLE XIII. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **American Agricultural Chemical Co., New York City.**		
1733	AAC Acme Fertilizer	1-9-4	Meriden
1489	AAC Aroostook Potato Manure	5-8-7	Plantsville
1827	AAC Aroostook Potato Manure	5-8-7	Bristol
1741	AAC Complete General Fertilizer	3-8-4	Norfolk
1842	AAC Double A Tobacco Fertilizer	5-3-5	West Suffield
1493	AAC Gladiator Fertilizer	4-8-7	New Britain
1491	AAC Grass & Lawn Top Dressing	6-6-4	Farmington
1846	AAC Hi Grade Tobacco Manure	7-3-7	Glastonbury
1490	AAC Monarch Fertilizer	4-8-4	Plantsville
1737	AAC Prolific 10% Potash Fertilizer	2-8-10	North Haven
2128	AAC Prolific 10% Potash Fertilizer	2-8-10	Canaan
2126	AAC Prolific 10% Potash Fertilizer	2-8-10	North Haven
1497	AAC Special Grass Top Dressing	8-6-6	Simsbury
1495	Agrico for Corn	3-10-6	New Canaan
1498	Agrico for Potatoes	4-8-6	Simsbury
1492	Agrico for Truck	5-10-5	Farmington
1826	Agrico for Truck	5-10-5	Farmington
1513	Bowker's All Round Fertilizer	3-8-4	New Canaan
1512	Bowker's Market Garden Fertilizer	4-8-4	New Canaan
1736	Bowker's Potato and Vegetable Phosphate	2-9-3	Portland
1516	Bowker's Stockbridge Hill and Drill Fertilizer	4-8-7	Bristol
1840	Bowker's Stockbridge Tobacco Manure	5-3-5	Thompsonville
1515	Bradley's Blood, Bone and Potash	5-8-7	Simsbury
1571	Bradley's Complete Manure for Potatoes and Vegetables	4-8-7	Broad Brook
1570	Bradley's Complete Tobacco Manure	5-3-5	Broad Brook
1947	Bradley's Northland Potato Grower	4-8-4	North Franklin
1948	Bradley's Potato Fertilizer	2-9-3	Colchester
1510	Bradley's Potato Manure	3-8-4	Meriden
1509	Bradley's XL Superphosphate of Lime	3-10-4	Suffield
1572	Bradley's XL Superphosphate of Lime	3-10-4	Broad Brook
1508	National Aroostook Special Fertilizer	5-8-7	Farmington
1742	National Complete Tobacco Fertilizer	5-3-5	Simsbury
1507	National Market Garden Fertilizer	3-8-4	Farmington
1843	National Pine Tree State Potato Fertilizer	4-8-4	Thompsonville
1514	National Premier Potato Manure	4-8-7	Danbury
1841	Sanderson's Atlantic Coast Mixture	3-10-4	Hamden
1844	Sanderson's Complete Tobacco Grower	5-3-5	Warehouse Point
1740	Sanderson's Corn Superphosphate	2-9-3	Canaan
1511	Sanderson's Formula A	4-8-4	Guilford
1566	Sanderson's Formula B	4-8-7	Glastonbury

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH.

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In Nitrates.	In Ammonia.	Organic water-soluble.	Organic water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As Muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
0.04	0.24	0.49	0.23	1.00	1.22	0.25	9.15	8.90	4.02	4.02	1733
0.62	2.52	0.43	0.36	3.93	4.78	0.46	8.65	8.19	6.38	6.38	1439
0.56	2.68	0.45	0.42	4.11	5.00	0.60	8.60	8.00	6.69	6.69	1827
0.00	1.58	0.52	0.38	2.48	3.02	0.18	8.25	8.07	4.19	4.19	1741
0.38	1.34	0.30	2.21	4.23	5.14	0.15	3.44	3.29	0.62	4.60	1842
0.34	2.02	0.56	0.45	3.37	4.10	0.13	8.25	8.12	7.15	7.15	1493
0.54	3.80	0.19	0.46	4.99	6.07	0.16	6.65	6.49	4.22	4.22	1491
0.32	1.18	0.77	3.49	5.76	7.00	0.21	3.90	3.69	0.69	8.26	1846
0.36	2.04	0.55	0.37	3.32	4.04	0.47	8.60	8.13	3.96	3.96	1490
0.00	0.90	0.52	0.32	1.74	2.11	0.30	8.60	8.30	9.26	9.26	1737
0.22	0.88	0.35	0.26	1.71	2.08	0.15	8.35	8.20	9.94	9.94	2128
0.00	1.02	0.42	0.30	1.74	2.11	0.28	8.30	8.02	9.97	9.97	2126
0.94	4.78	0.17	0.70	6.59	8.01	0.20	6.75	6.55	5.97	5.97	1497
0.12	1.52	0.51	0.35	2.50	3.04	0.28	10.25	9.97	6.17	6.17	1495
0.24	2.08	0.53	0.51	3.36	4.09	0.15	7.95	7.80	6.00	6.00	1498
0.46	2.54	0.54	0.52	4.06	4.94	0.58	10.24	9.66	5.12	5.12	1492
0.50	2.52	0.47	0.46	3.95	4.80	0.67	10.52	9.85	5.30	5.30	1826
0.00	1.60	0.47	0.40	2.47	3.00	0.23	8.15	7.92	4.23	4.23	1513
0.32	2.00	0.61	0.43	3.36	4.09	0.50	8.50	8.00	4.02	4.02	1512
0.04	0.92	0.41	0.35	1.72	2.09	0.25	8.95	8.70	3.09	3.09	1736
0.26	1.96	0.56	0.57	3.35	4.07	0.30	8.23	7.93	7.33	7.33	1516
0.46	1.12	0.38	2.09	4.05	4.92	0.15	3.35	3.20	0.43	5.41	1840
0.48	2.72	0.40	0.51	4.11	5.00	0.45	8.50	8.05	7.03	7.03	1515
0.30	2.16	0.36	0.49	3.31	4.02	0.28	8.15	7.87	7.36	7.36	1571
0.40	1.44	0.19	2.29	4.32	5.25	0.23	3.43	3.20	0.29	5.12	1570
0.38	2.00	0.47	0.42	3.27	3.98	0.48	8.50	8.02	4.03	4.03	1947
0.00	0.90	0.51	0.27	1.68	2.04	0.20	8.78	8.58	4.76	4.76	1948
0.04	1.64	0.44	0.40	2.52	3.06	0.21	8.08	7.87	4.06	4.06	1510
0.06	1.58	0.53	0.38	2.55	3.10	0.30	10.38	10.08	4.02	4.02	1509
0.12	1.62	0.45	0.42	2.61	3.17	0.45	10.10	9.65	4.72	4.72	1572
0.48	2.84	0.39	0.44	4.15	5.05	0.53	8.68	8.15	6.90	6.90	1508
0.52	1.28	0.20	2.12	4.12	5.01	0.17	3.53	3.36	0.58	5.08	1742
0.10	1.70	0.66	0.38	2.54	3.09	0.18	8.25	8.07	4.07	4.07	1507
0.36	2.00	0.49	0.42	3.27	3.98	0.41	8.90	8.49	4.03	4.03	1843
0.40	1.96	0.39	0.48	3.23	3.93	0.30	8.53	8.23	7.06	7.06	1514
0.00	1.84	0.49	0.45	2.78	3.38	0.25	9.90	9.65	5.45	5.45	1841
0.18	1.34	0.50	2.12	4.14	5.03	0.15	3.48	3.33	0.57	5.23	1844
0.00	0.94	0.53	0.33	1.80	2.19	0.25	9.38	9.13	3.39	3.39	1740
0.36	2.00	0.58	0.42	3.36	4.09	0.49	8.58	8.09	3.93	3.93	1511
0.44	2.28	0.02	0.55	3.29	4.00	0.28	8.30	8.02	0.70	6.94	1566

TABLE XIII. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **American Agricultural Chemical Co., New York City.**		
1739	Sanderson's Formula B	4-8-7	Gaylordsville
1567	Sanderson's Potato Manure	3-8-4	Derby
1942	Sanderson's Potato Manure	3-8-4	Derby
	Apothecaries Hall Co., Waterbury, Conn.		
1835	Liberty Corn and All Crops 2-8-2	2-8-2	Norwich
1755	Liberty Corn, Fruit and All Crops 2-12-4	2-12-4	Greenwich
1743	Liberty Double Strength 10-16-14	10-16-14	Sampled at factory
1517	Liberty Fish, Bone and Potash 3-8-3	3-8-3	North Haven
1520	Liberty High Grade Market Gardener's 5-8-7	5-8-7	West Cheshire
1953	Liberty High Grade Tobacco Manure 7-3-7	7-3-7	Sampled at factory
1759	Liberty Onion Special 4-8-7	4-8-7	Sampled at factory
1837	Liberty Potato and General Crop 4-8-10	4-8-10	Norwich
1506	Liberty Potato and Market Gardener's Special 4-8-4	4-8-4	West Cheshire
1836	Liberty Potato and Vegetable 2-8-10	2-8-10	Norwich
1756	Liberty Special Fertilizer for Fruit 7-8-6	7-8-6	Torrington
1955	Liberty Tobacco Special C. S. M. Base 5-3-5	5-3-5	Sampled at factory
1838	Liberty Top Dresser for Grass and Grain 10-3½-8	10-3.5-8	Norwich
	Armour Fertilizer Works, New York City.		
1581	Armour's Big Crop Fertilizer 2-12-4	2-12-4	Wethersfield
1575	Armour's Big Crop Fertilizer 3-8-4	3-8-4	Meriden
1881	Armour's Big Crop Fertilizer 4-6-10	4-6-10	Granby
1761	Armour's Big Crop Fertilizer 4-16-4	4-16-4	Wallingford
1577	Armour's Big Crop Fertilizer 4-8-4	4-8-4	Danbury
1580	Armour's Big Crop Fertilizer 5-8-7	5-8-7	Wethersfield
1762	Armour's Big Crop Fertilizer 7-11-10	7-11-10	Wallingford
1578	Armour's Big Crop Fertilizer 8-6-6	8-6-6	Thompsonville
1769	Armour's Big Crop Tobacco Special 5-3-5	5-3-5	Enfield
1882	Armour's Big Crop Tobacco Special 5-3-5	5-3-5	Granby
	Associated Seed Growers, Inc., New Haven, Conn.		
1528	Tip Top Brand	5-8-7	Associated Seed Growers, Inc., Milford
1529	Special Mixture for General Use	4-8-4	Associated Seed Growers, Inc., Milford

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.						Phosphoric Acid.			Potash.		
In Nitrates.	In Ammonia.	Organic water-soluble.	Organic water-insoluble.	Total.	Ammonia equivalent to total nitrogen.	Citrate-insoluble.	Total.	So-called "Available."	As Muriate.	Total.	Station No.
%	%	%	%	%	%	%	%	%	%	%	
28	1.80	0.63	0.59	3.30	4.01	0.30	8.25	7.95	0.93	7.25	1739
14	1.62	0.30	0.37	2.43	2.95	0.25	8.18	7.93	3.88	3.88	1567
08	1.58	0.47	0.44	2.57	3.12	0.20	8.33	8.13	4.04	4.04	1942
06	1.22	0.29	0.64	2.21	2.69	1.40	8.93	7.53	2.73	2.73	1835
08	1.64	0.44	0.14	2.30	2.80	1.63	13.20	11.57	4.21	4.21	1755
00	3.24	3.00	0.44	7.68	9.34	0.48	16.49	16.01	13.72	13.72	1743
00	1.08	0.31	1.64	3.03	3.68	1.25	8.93	7.68	3.46	3.46	1517
80	2.96	0.34	0.16	4.26	5.18	1.05	8.90	7.85	7.07	7.07	1520
00	1.88	0.43	3.72	6.03	7.33	0.78	4.74	3.96	0.86	8.31	1953
26	1.70	0.61	0.77	3.34	4.06	4.18	12.82	8.64	0.78	10.70	1759
50	1.06	0.50	0.44	3.50	4.26	0.83	8.65	7.82	11.02	11.02	1837
00	2.04	0.50	0.81	3.35	4.07	1.13	9.35	8.22	4.13	4.13	1506
18	0.98	0.44	0.54	2.14	2.60	0.75	8.02	7.27	11.27	11.27	1836
96	2.04	0.25	0.59	5.84	7.10	1.43	9.38	7.95	6.17	6.17	1756
00	1.66	0.24	2.55	4.45	5.41	0.58	4.79	4.21	0.35	6.69	1955
58	3.02	0.00	0.71	8.31	10.10	0.06	3.93	3.87	10.59	10.59	1838
36	1.20	0.38	0.04	1.98	2.41	0.75	12.40	11.65	4.02	4.02	1581
18	2.06	0.13	0.05	2.42	2.94	0.25	8.15	7.90	4.04	4.04	1575
52	2.40	0.30	0.05	3.27	3.98	0.30	6.64	6.34	9.69	9.69	1881
68	2.34	0.33	0.08	3.43	4.17	0.31	16.51	16.20	4.32	4.32	1761
.38	2.44	0.28	0.11	3.21	3.90	0.41	8.26	7.85	4.19	4.19	1577
00	3.08	0.96	0.08	4.12	5.01	0.55	8.95	8.40	6.55	6.55	1580
.32	4.12	0.19	0.04	5.67	6.89	0.14	11.63	11.49	10.22	10.22	1762
06	5.00	0.28	0.07	6.41	7.79	0.35	6.79	6.44	6.01	6.01	1578
72	0.02	0.47	1.91	4.12	5.01	0.38	3.73	3.35	0.61	4.97	1769
.46	0.12	0.29	2.32	4.19	5.09	0.36	4.25	3.89	0.64	5.62	1882
46	1.46	0.14	1.30	4.36	5.30	0.30	8.35	8.05	7.04	7.04	1528
92	1.48	0.17	0.93	3.50	4.26	0.25	8.35	8.10	6.96	6.96	1529

TABLE XIII. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **Associated Seed Growers, Inc., New Haven, Conn.**		
1530	Special Mixture 6% Potash	4-8-6	Associated Seed Growers, Inc., Milford
	F. A. Bartlett Tree Expert Co., Stamford, Conn.		
1440	Bartlett Green Tree Food	6-7-4	Sampled at factor
	Berkshire Chemical Co., Bridgeport, Conn.		
1521	Berkshire Complete Fertilizer	2-9-3	Southport
1883	Berkshire Complete Tobacco Fertilizer	5-3-5	Granby
1574	Berkshire Economical Grass Fertilizer	10-3-8	Sampled at factor
1920	Berkshire Economical Grass Fertilizer	10-3-8	Ellington
1374	Berkshire Grass Special Fertilizer	7-6-5	Hamden
1376	Berkshire Long Island Special Fertilizer	5-8-7	Hamden
1377	Berkshire Market Garden Fertilizer	4-8-4	Hamden
1884	Berkshire Tobacco Special Fertilizer	7-3-7	Granby
1885	Berkshire Tobacco Starter Fertilizer	5-8-10	Ellington
1583	Berkshire Truck Fertilizer	5-8-5	North Haven
	Amos D. Bridge's Sons, Inc., Hazardville, Conn.		
1673	Corn, Onion, Potato and General Purpose	4-8-4	Sampled at factor
1950	Special Tobacco Fertilizer	5-3-5	Sampled at factor
	E. D. Chittenden Co., Bridgeport, Conn.		
2043	Chittenden's Complete Tobacco and Onion Grower	4-8-4	Tolland
2042	Chittenden's High Grade Potato 7% Potash	5-8-7	Tolland
2044	Chittenden's Potato Special 4% Potash	4-8-4	Abington
2066	Chittenden's Tobacco Special	5-4-5	Wapping
	C & R Sales Co., Worcester, Mass.		
1958	C & R Lawn and Shrub Fertilizer 5-6-5	5-6-5	Putnam
	Davey Tree Expert Co., Inc., Kent, Ohio.		
1441	Davey Tree Food	10-3-3	Sound Beach

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.						Phosphoric Acid.			Potash.		
In Nitrates.	In Ammonia.	Organic water-soluble.	Organic water-insoluble.	Total.	Ammonia equivalent to total nitrogen.	Citrate-insoluble.	Total.	So-called "Available."	As Muriate.	Total.	Station No.
%	%	%	%	%	%	%	%	%	%	%	
0 92	1.36	0.22	1.00	3.50	4.26	0.30	8.23	7.93	7.40	7.40	1530
0.28	4.26	0.00	0.86	5.40	6.57	2.18	10.20	8.02	5.22	5.22	1440
0.04	0.90	0.39	0.67	2.00	2.43	2.63	11.79	9.16	3.91	3.91	1521
1.02	0.00	0.46	2.54	4.02	4.89	0.08	4.23	4.15	0.84	5.69	1883
7.24	0.00	0.29	0.48	8.01	9.74	1.06	9.03	7.97	1.55	8.81	1574
6.96	0.00	0.79	0.81	8.56	10.41	1.79	9.25	7.46	2.07	9.77	1920
2.08	2.12	0.37	1.08	5.65	6.87	0.20	6.58	6.38	6.09	6.09	1374
0.20	2.52	0.41	0.90	4.03	4.90	0.10	8.08	7.98	8.96	8.96	1376
1.24	1.40	0.32	0.69	3.65	4.44	0.27	8.60	8.33	5.09	5.09	1377
1.84	0.12	0.67	3.16	5.79	7.04	0.13	4.03	3.90	0.72	7.48	1884
2.02	1.34	0.47	0.72	4.55	5.53	0.18	9.23	9.05	0.74	9.38	1885
0.00	2.62	0.40	1.02	4.04	4.91	0.20	7.95	7.75	6.79	6.79	1583
0.84	1.86	0.00	0.60	3.30	4.01	1.10	9.25	8.15	4.51	4.51	1673
0.94	0.00	0.41	3.00	4.35	5.29	0.47	4.50	4.03	0.36	5.85	1950
0.00	2.80	0.08	0.36	3.24	3.94	0.30	8.19	7.89	2.27	4.59	2043
0.00	3.48	0.15	0.39	4.02	4.89	0.31	8.43	8.12	2.47	7.04	2042
0.00	2.96	0.07	0.29	3.32	4.04	0.45	8.51	8.06	4.57	4.57	2044
0.00	2.60	0.30	1.27	4.17	5.07	0.23	5.29	5.06	1.28	5.50	2066
0.00	2.00	0.54	2.27	4.81	5.85	0.28	7.15	6.87	7.01	7.01	1958
0.00	5.38	1.01	2.00	8.39	10.20	3.63	8.45	4.82	3.14	3.14	1441

Table XIII. Analyses of Mixed Fertilizers

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **Eastern States Farmers' Exchange, Springfield, Mass.**[1]		
1763	Eastern States Open Formula 4-8-8	4-8-8	North Haven
1582	Eastern States Open Formula 4-10-6	4-10-6	Ellington
1764	Eastern States Open Formula 4-12-4	4-12-4	North Haven
1765	Eastern States Open Formula 4-20-16	4-20-16	Clinton
1522	Eastern States Open Formula 6-8-6	6-8-6	North Haven
1531	Eastern States Open Formula 6-15-9	6-15-9	Meriden
1757	Eastern States Open Formula 6-18-6	6-18-6	West Simsbury
1970	Eastern States Open Formula 8-4-8	8-4-8	New Milford
1523	Eastern States Open Formula 8-16-16	8-16-16	North Haven
1966	Eastern States Open Formula 8-16-16	8-16-16	Buckland
1973	Eastern States Open Formula 8-16-16	8-16-16	Woodstock
1791	Eastern States Open Formula 10-5-10	10-5-10	West Simsbury
	Essex Fertilizer Co., Boston, Mass.		
1525	Essex Complete Manure 5-8-7	5-8-7	Wallingford
1526	Essex Fish Fertilizer for All Crops 3-8-4	3-8-4	Wallingford
1943	Essex Fish Fertilizer for All Crops 3-8-4	3-8-4	Cromwell
1524	Essex Market Garden 4-8-4	4-8-4	Wallingford
1527	Essex Peerless Potato Manure 4-6-10	4-6-10	Wallingford
1786	Essex Top Dressing	7-6-5	So. Manchester
	Friedman Tobacco Products Corp., York, Pa.[1]		
1378	Tobacco Dust Fertilizer	2-4-2[2]	Hamden
	L. T. Frisbie Co., New Haven, Conn.		
1445	Frisbie's Corn and Grain Fertilizer 2-10-2	2-10-2	Danbury
1784	Frisbie's 5-8-7	5-8-7	Wethersfield
1790	Frisbie's 5-10-5	5-10-5	Winsted
1438	Frisbie's Market Garden 5-8-7	5-8-7	Wethersfield
1787	Frisbie's Special 3-8-4	3-8-4	Waterbury
1439	Frisbie's Special Vegetable and Potato Grower 4-8-4	4-8-4	Guilford
1971	Frisbie's Tobacco Grower 7-3-7	7-3-7	Buckland
1444	Frisbie's Top Dresser 8-6-6	8-6-6	Danbury

[1] First figure in "grade" column represents "nitrogen," not ammonia.
[2] Total P.O.

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In Nitrates.	In Ammonia.	Organic water-soluble.	Organic water-*insoluble.*	Total.		Citrate-insoluble.	*Total.*	So-called "Available."	As Muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
0.94	2.28	0.79	0.24	4.25	5.17	0.31	9.73	9.42	7.47	7.47	1763
0.82	2.44	0.00	0.72	3.98	4.84	0.58	11.13	10.55	6.04	6.04	1582
1.62	2.00	0.26	0.24	4.12	5.01	0.44	12.85	12.41	4.56	4.56	1764
1.14	2.50	0.43	0.34	4.41	5.36	0.28	21.60	21.32	15.09	15.09	1765
2.14	3.08	0.29	0.85	6.36	7.73	0.23	8.40	8.17	6.41	6.41	1522
1.36	4.02	0.28	0.39	6.05	7.36	0.35	15.58	15.23	9.43	9.43	1531
1.02	4.16	0.57	0.68	6.43	7.82	0.55	19.50	18.95	6.59	6.59	1757
2.44	0.44	3.40	2.52	8.80	10.70	0.09	5.43	5.34	1.70	9.94	1970
1.50	5.88	0.15	0.80	8.33	10.13	0.40	20.15	19.75	13.45	13.45	1523
1.32	5.20	0.88	0.38	7.78	9.46	0.28	16.30	16.02	17.24	17.24	1966
1.58	5.12	0.58	0.42	7.70	9.36	0.45	17.30	16.85	16.04	16.04	1973
3.42	0.56	5.18	2.11	11.27	13.70	0.15	5.54	5.39	1.86	10.52	1791
0.36	2.52	0.57	0.67	4.12	5.01	0.78	8.78	8.00	6.58	6.58	1525
0.00	0.67	1.11	0.64	2.42	2.94	1.18	8.30	7.12	4.06	4.06	1526
0.00	1.48	0.51	0.72	2.71	3.29	0.81	8.48	7.67	4.36	4.36	1943
0.40	1.84	0.45	0.76	3.45	4.19	0.83	8.83	8.00	4.00	4.00	1524
0.40	1.88	0.35	0.76	3.39	4.12	0.38	6.70	6.32	10.08	10.08	1527
0.00	5.64	0.00	0.11	5.75	6.99	0.03	6.25	6.22	4.94	4.94	1786
0.16	0.20	0.36	1.41	2.13	2.59	0.08	0.50	0.42	0.80	2.62	1378
0.08	0.58	0.50	0.59	1.75	2.13	0.55	10.16	9.61	2.12	2.12	1445
0.32	3.08	0.51	0.34	4.25	5.17	0.37	9.00	8.63	0.49	7.05	1784
0.30	3.20	0.42	0.35	4.27	5.19	0.64	10.76	10.12	5.41	5.41	1790
0.24	3.16	0.57	0.33	4.30	5.23	0.48	8.90	8.42	6.83	6.83	1438
0.10	1.52	0.37	0.65	2.64	3.21	0.57	8.74	8.17	4.17	4.17	1787
0.36	1.96	0.32	0.65	3.29	4.00	0.35	8.30	7.95	4.09	4.09	1439
1.56	0.44	0.03	4.00	5.73	6.97	0.13	4.60	4.47	1.08	7.91	1971
1.24	4.84	0.24	0.34	6.66	8.10	0.30	6.70	6.40	5.71	5.71	1444

TABLE XIII. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **Grasselli Chemical Co., Cleveland, Ohio.**		
1785	Grasselli Odorless Plant Food	5-13-4	Fair Haven
	International Agricultural Corp., Boston, Mass.		
2048	I. A. C. Caribee Tobacco Fertilizer	7-6-5	West Suffield
1886	Premium Tobacco Fertilizer	7-9-8	Hockanum
	Lowell Fertilizer Co., Boston, Mass.		
1456	Lowell Animal Brand, A High Grade Manure for All Crops, 3-8-4	3-8-4	Southington
1788	Lowell Bone Fertilizer 2-10-2	2-10-2	Southbury
1457	Lowell Corn and Vegetable 4-8-4	4-8-4	Southington
1519	Lowell Corn and Vegetable 4-8-4	4-8-4	Cheshire
1462	Lowell Market Garden 5-8-7	5-8-7	Cheshire
1789	Lowell Potato Grower 4-6-10	4-6-10	Southbury
2116	Lowell Tobacco 5-3-5	5-3-5	Warehouse Point
1461	Lowell Top Dressing 7-6-5	7-6-5	Cheshire
	Maine Farmers' Exchange, Portland, Me.		
1963	M. F. E. "Produce More" 3-10-3	3-10-3	New Milford
1964	M. F. E. "Produce More" 4-8-5	4-8-5	New Milford
1965	M. F. E. "Produce More" 5-8-7	5-8-7	New Milford
	Mapes Formula and Peruvian Guano Co., New York City.		
1807	Mapes Conn. Valley Special	6-4-7	East Granby
1800	Mapes Corn Manure	3-8-3	Windsor Locks
1808	Mapes General Tobacco Manure	5-4-5	East Granby
1805	Mapes General Truck Manure	5-6-5	Hartford
1801	Mapes General Use Manure	3-6-4	Windsor Locks
1804	Mapes Onion Manure	4-6-4	Hartford
1783	Mapes Potato Manure	4-7-5	Windsor Locks
1802	Mapes Special Trucker	5-8-7	Hartford
1806	Mapes Special Trucker "SP"	5-8-7	Hartford
1918	Mapes Tobacco Ash Constituents	1-4-15	West Suffield
1810	Mapes Tobacco Ash and Starter	4-6-15	Hartford
1967	Mapes Tobacco Manure Wrapper Brand	7.5-2-10.5	Windsor
1799	Mapes Tobacco Starter Improved	5-6-1	Windsor Locks
1803	Mapes Top Dresser	10-4-2	Hartford

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In Nitrates.	In Ammonia.	Organic water-soluble.	Organic water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As Muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
0.00	3.76	0.12	0.12	4.00	4.86	1.14	16.80	15.66	4.90	4.90	1785
0.56	2.84	0.44	2.01	5.85	7.11	0.22	6.90	6.68	0.98	5.85	2048
0.00	2.54	0.95	2.38	5.87	7.14	0.20	9.00	8.80	0.70	8.21	1886
0.00	1.36	0.53	0.70	2.59	3.15	1.15	8.88	7.73	4.14	4.14	1456
0.00	0.92	0.39	0.35	1.66	2.02	1.21	11.31	10.10	2.24	2.24	1788
0.28	1.96	0.49	0.69	3.42	4.16	0.95	8.85	7.90	4.16	4.16	1457
0.36	1.68	0.54	0.76	3.34	4.06	0.70	8.50	7.80	3.97	3.97	1519
0.64	2.90	0.05	0.48	4.07	4.95	0.80	8.65	7.85	6.89	6.89	1462
0.42	1.92	0.32	0.74	3.40	4.13	0.34	6.82	6.48	10.35	10.35	1789
0.80	0.00	0.57	2.74	4.11	5.00	0.24	4.38	4.14	0.93	5.81	2116
0.14	5.50	0.00	0.00	5.64	6.86	0.13	5.50	5.37	5.14	5.14	1461
0.08	1.56	0.49	0.87	3.00	3.65	0.57	11.13	10.56	1.25	4.04	1963
0.34	1.80	1.12	1.02	4.28	5.20	0.45	9.41	8.96	1.69	5.40	1964
0.34	1.56	1.80	0.91	4.61	5.60	0.39	8.68	8.29	3.77	7.00	1965
2.44	0.06	1.58	1.42	5.50	6.69	1.00	5.39	4.39	0.68	7.27	1807
0.26	1.02	1.13	0.48	2.89	3.51	1.24	10.75	9.51	2.72	3.06	1800
1.54	0.04	1.02	1.58	4.18	5.08	1.20	5.50	4.30	0.54	6.26	1808
0.38	3.80	0.00	0.51	4.69	5.70	0.93	8.74	7.81	3.71	4.56	1805
0.46	1.02	1.06	0.35	2.89	3.51	1.00	8.73	7.73	3.75	4.40	1801
0.44	2.88	0.00	0.44	3.76	4.57	0.83	8.47	7.64	0.39	4.19	1804
0.26	2.34	0.30	0.42	3.32	4.04	0.74	8.45	7.71	4.93	5.07	1783
0.36	1.72	1.74	0.60	4.42	5.37	1.07	10.85	9.78	7.09	7.09	1802
0.38	3.40	0.10	0.51	4.39	5.34	0.95	10.33	9.38	0.60	7.47	1806
0.00	0.00	0.42	0.88	1.30	1.58	1.89	6.18	4.29	0.94	17.38	1918
2.22	0.16	0.76	0.50	3.64	4.43	0.81	7.58	6.77	0.70	15.29	1810
3.08	0.08	1.60	1.43	6.19	7.53	0.87	5.33	4.46	0.77	11.92	1967
3.00	0.00	1.29	0.54	4.83	5.87	1.36	8.73	7.37	0.16	1.51	1799
2.22	2.98	3.08	0.30	8.58	10.43	0.52	6.40	5.88	2.01	2.39	1803

TABLE XIII. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **A. G. Markham & Co., Springfield, Mass.**		
1914	4-6-10	4-6-10	Mansfield Depot
1913	4-8-4	4-8-4	Mansfield Depot
1915	5-8-7	5-8-7	Stafford Springs
	Millane Tree Expert Co., Cromwell, Conn.		
2223	Millane Shade Tree Food	10-12-4	Sampled at factory
	New England Fertilizer Co., Boston, Mass.		
1809	New England Complete Manure 4-6-10	4-6-10	Unionville
1975	New England Corn Phosphate 2-10-2	2-10-2	Mansfield Depot
1919	New England Market Garden Manure 5-8-7	5-8-7	West Suffield
1465	New England Potato and Vegetable Manure 4-8-4	4-8-4	Meriden
1466	New England Super, A High Grade Fertilizer for all Crops 3-8-4	3-8-4	Meriden
1974	New England Tobacco Manure 5-3-5	5-3-5	Unionville
	Old Deerfield Fertilizer Co., South Deerfield, Mass.		
1981	Old Deerfield Tobacco Starter Bone and Potash	6-8-12	Suffield
	Olds & Whipple, Inc., Hartford, Conn.		
1793	O & W Blue Label Tobacco Fertilizer	6-3-6	Ellington
1541	O & W Complete Market Garden Fertilizer	4-8-4	So. Manchester
2047	O & W Complete Tobacco Fertilizer	5-3-5	So. Windsor
1474	O & W Grass Fertilizer	6-6-4	So. Manchester
1473	O & W High Grade Potato and Vegetable Fertilizer	5-8-7	So. Manchester
1977	O & W High Grade Starter and Potash Compound	5-4-15	So. Windsor
	Parmenter & Polsey, Boston, Mass.		
1822	P & P Maine Potato Fertilizer 4-6-10	4-6-10	Wallingford
1976	Parmenter & Polsey Top Dressing 7-6-5	7-6-5	Wallingford

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In Nitrates.	In Ammonia.	Organic water-soluble.	Organic water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As Muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
0.56	2.20	0.28	0.32	3.36	**4.09**	0.22	6.38	**6.16**	9.57	**9.57**	**1914**
0.32	1.92	0.51	0.47	3.22	**3.91**	0.66	8.28	**7.62**	4.04	**4.04**	**1913**
0.54	2.80	0.36	0.48	4.18	**5.08**	0.43	8.65	**8.22**	7.14	**7.14**	**1915**
4.24	2.48	0.57	0.29	7.58	**9.22**	1.45	14.15	**12.70**	4.42	**4.42**	**2223**
0.18	1.88	0.66	0.48	3.20	**3.89**	0.45	6.81	**6.36**	9.77	**9.77**	**1809**
0.00	1.00	0.46	0.37	1.83	**2.22**	0.36	10.53	**10.17**	2.40	**2.40**	**1975**
0.36	3.10	0.44	0.37	4.27	**5.19**	0.52	8.85	**8.33**	7.22	**7.22**	**1919**
0.34	1.86	0.46	0.56	3.22	**3.91**	0.83	8.75	**7.92**	3.85	**3.85**	**1465**
0.04	1.68	0.25	0.56	2.53	**3.08**	0.83	8.62	**7.79**	3.91	**3.91**	**1466**
0.94	0.20	0.40	2.64	4.18	**5.08**	0.28	4.70	**4.42**	1.12	**6.23**	**1974**
1.92	0.42	1.23	1.86	5.43	**6.60**	0.45	8.80	**8.35**	1.29	**13.05**	**1981**
1.08	0.00	0.53	3.56	5.17	**6.29**	0.38	4.12	**3.74**	0.36	**6.51**	**1793**
0.78	1.68	0.20	0.73	3.39	**4.12**	1.13	9.33	**8.20**	4.15	**4.15**	**1541**
0.74	0.00	0.51	2.97	4.22	**5.13**	0.42	3.99	**3.57**	0.44	**5.95**	**2047**
2.30	1.70	0.29	0.70	4.99	**6.07**	0.71	7.00	**6.29**	4.12	**4.12**	**1474**
1.06	2.00	0.18	0.91	4.15	**5.05**	0.99	9.25	**8.26**	7.55	**7.55**	**1473**
0.98	1.02	0.23	2.27	4.50	**5.47**	0.70	5.63	**4.93**	1.79	**14.99**	**1977**
0.42	2.00	0.50	0.52	3.44	**4.18**	0.43	6.65	**6.22**	10.40	**10.40**	**1822**
0.00	5.40	0.18	0.11	5.69	**6.92**	0.13	6.55	**6.42**	5.10	**5.10**	**1976**

TABLE XIII. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **Piedmont Mt. Airy Guano Co., Baltimore, Md.**		
1984	Harvest Brand 2-8-3	2-8-3	Plantsville
1985	Harvest Brand 4-8-4	4-8-4	Plantsville
1983	Harvest Brand 5-8-7	5-8-7	Plantsville
	Frank S. Platt Co., New Haven, Conn.		
1819	Platt's Concentrated Lawn Fertilizer	16-5-5	Sampled at factory
1818	Platco Special 5-8-7	5-8-7	Sampled at factory
	Rackliffe Bros. Co., New Britain, Conn.		
1535	Rackliffe Brand Corn Fertilizer 4-8-4	4-8-4	Sampled at factory
1536	Rackliffe Brand Potato and Special Vegetable 5-8-7	5-8-7	Sampled at factory
	The Rogers & Hubbard Co., Portland, Conn.		
1470	4-8-4 Fertilizer	4-8-4	Hartford
1471	5-8-7 Fertilizer	5-8-7	Hartford
1540	5-10-5 Fertilizer	5-10-5	Sampled at factory
1539	Hubbard's "Bone Base" Fertilizer for Seeding Down	3-5-6	Sampled at factory
1542	Hubbard's "Bone Base" Oats and Top Dressing	10-3-8	Norwich
1922	Hubbard's "Bone Base" Oats and Top Dressing	10-3-8	Sampled at factory
1544	Hubbard's "Bone Base" Soluble Corn and General Crop Manure	3-8-6	Fair Haven
1816	Hubbard's "Bone Base" Soluble Potato Manure	6-8-5	Higganum
1979	Hubbard's "Bone Base" Soluble Tobacco Manure	6-8-10	So. Windsor
1815	Lawn Fertilizer	7.5-2-4.5	New Britain
1817	Rogers & Hubbard All Soils, All Crops Fertilizer	4-10-4	Higganum
1814	Rogers & Hubbard's Corn and Grain Fertilizer	1-10-3	Willimantic
1824	R & H Climax Tobacco Brand	5-3-5	Granby
1478	R & H High Potash Fertilizer	3-8-10	New Britain
1825	R & H High Potash Fertilizer	3-8-10	Branford
1813	Rogers & Hubbard's Potato Fertilizer	2-10-4	Willimantic
1823	R & H Tobacco Grower Vegetable Formula	6-3-5	Granby
1982	R & H Tunaker for Tobacco	10-4-10	East Granby
2230	R & H Tunaker for Tobacco	10-4-10	Sampled at factory

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In Nitrates.	In Ammonia.	Organic water-soluble.	Organic water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As Muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
).00	0.86	0.65	0.36	1.87	2.27	1.43	8.73	7.30	4.11	4.11	1984
).00	2.26	0.58	0.25	3.09	3.76	0.66	8.69	8.03	4.35	4.35	1985
).00	3.56	0.59	0.23	4.38	5.33	0.20	8.33	8.10	7.24	7.24	1983
).00	13.48	0.28	0.60	14.36	17.46	0.09	5.83	5.74	0.48	6.58	1819
).22	3.08	0.52	0.46	4.28	5.20	0.56	8.90	8.34	7.10	7.10	1818
).38	1.94	0.38	0.58	3.28	3.99	0.39	8.55	8.16	4.21	4.21	1535
ı.34	3.04	0.44	0.40	4.22	5.13	0.53	8.55	8.02	7.09	7.09	1536
).10	2.66	0.61	0.15	3.52	4.28	0.20	8.70	8.50	4.03	4.03	1470
).18	3.52	0.30	0.12	4.12	5.01	0.18	8.87	8.59	6.84	6.84	1471
).12	3.42	0.62	0.24	4.40	5.35	0.20	10.61	10.41	5.31	5.31	1540
).94	0.22	0.00	1.26	2.42	2.94	5.88	12.50	6.62	6.80	6.80	1539
'.68	0.16	0.02	0.29	8.15	9.91	2.13	8.71	6.58	3.96	8.62	1542
'.70	0.00	0.39	0.18	8.27	10.05	2.05	8.58	6.53	2.87	8.30	1922
).40	0.50	1.12	0.44	2.46	2.99	1.43	9.73	8.30	5.77	6.07	1544
[.18	2.12	0.98	0.68	4.96	6.03	1.23	10.20	8.97	0.85	5.07	1816
).96	2.24	1.25	0.53	4.98	6.05	1.33	10.01	8.68	0.78	10.44	1979
3.96	0.00	0.45	2.30	6.71	8.16	0.54	4.58	4.04	2.71	5.70	1815
).12	2.08	0.66	0.42	3.28	3.99	0.75	11.03	10.28	4.62	4.62	1817
).06	0.16	0.51	0.13	0.86	1.05	0.59	11.05	10.46	3.41	3.41	1814
l.76	0.06	0.51	2.11	4.44	5.40	0.43	4.00	3.57	0.54	5.59	1824
).16	1.44	0.74	0.40	2.74	3.33	0.88	8.50	7.62	10.31	10.31	1478
).28	1.10	1.02	0.32	2.72	3.31	0.63	8.65	8.02	9.86	9.86	1825
).10	0.74	0.61	0.29	1.74	2.11	0.53	10.75	10.22	4.99	4.99	1813
l.24	0.18	0.78	2.82	5.02	6.10	0.48	3.69	3.21	0.54	5.43	1823
).76	0.58	3.31	3.00	7.65	9.30	0.15	4.45	4.30	0.98	10.54	1982
l.34	0.16	3.13	2.89	7.52	9.14	0.15	4.10	3.95	0.70	10.93	2230

TABLE XIII. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **F. S. Royster Guano Co., Baltimore, Md.**		
1993	Royster's Conn. Tobacco Guano	5-3-5	Glastonbury
1646	Royster's Curlew Guano	3-10-6	Waterbury
1645	Royster's Quality Trucker	4-8-7	Waterbury
1994	Royster's Truckers Delight	4-8-4	Glastonbury
	M. L. Shoemaker & Co., Philadelphia, Pa.		
1671	Special Mixture of Bantle's Wrapper Brand	7-3-7	Glastonbury
1668	Swift-Sure Potato Special 5-8-7	5-8-7	New Milford
1672	Swift-Sure Special Tobacco Formula 4-8-5	4-8-5	Glastonbury
1669	Swift-Sure Tobacco and General Use 3-10-3	3-10-3	New Milford
	Springfield Rendering Co., Springfield, Mass.		
1820	Springfield 3-8-4 Fertilizer	3-8-4	Stafford Springs
1821	Springfield 4-8-4 Fertilizer	4-8-4	Stafford Springs
1839	Springfield 5-8-7 Fertilizer	5-8-7	Stafford Springs
2067	Springfield 5-3-5 Tobacco Special	5-3-5	West Springfield
1674	Springfield 7-6-5 Top Dresser	7-6-5	Hazardville
	Standard Wholesale Phosphate & Acid Works, Baltimore, Md.		
1845	5-4-5	5-4-5	Ellington
1604	5-10-5	5-10-5	Milford
1602	8-6-6	8-6-6	Seymour
1606	Evergreen Fish Guano	4-8-4	Norwalk
1603	Golden Rule Guano	4.11-6-10	Seymour
1605	Grain Grower	2-8-2	Norwalk
1999	High Analysis	4-16-4	Seymour
2003	Ideal Potato Grower	4-8-6	Silver Lane
1609	Mammoth Potato Grower	2-8-10	North Haven
1400	Standard U. S. Fish, Bone and Potash	5-8-7	Milford
	Swift & Co., Baltimore, Md.		
1599	Vigoro	4-12-4	Hartford

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Continued.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In Nitrates.	*In* Ammonia.	Organic water-soluble.	*Organic* water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "*Available.*"	As Muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
0.32	0.88	0.21	2.45	3.86	4.69	0.21	3.50	3.29	0.27	5.33	1993
0.12	1.66	0.33	0.48	2.59	3.15	1.18	11.33	10.15	5.41	5.41	1646
0.10	2.04	0.55	0.64	3.33	4.05	1.19	8.90	7.71	7.28	7.28	1645
0.00	2.00	0.63	0.67	3.30	4.01	0.73	8.85	8.12	4.22	4.22	1994
1.56	0.34	0.71	3.02	5.63	6.84	0.85	5.15	4.30	1.34	8.49	1671
0.00	2.84	0.37	1.13	4.34	5.28	2.18	9.40	7.22	6.84	6.84	1668
0.00	1.64	0.25	1.51	3.40	4.13	1.38	9.45	8.07	0.52	5.25	1672
0.00	0.87	1.08	0.74	2.69	3.27	1.50	11.50	10.00	0.44	3.13	1669
0.00	1.76	0.52	0.32	2.60	3.16	0.30	8.70	8.40	4.28	4.28	1820
0.26	1.98	0.56	0.50	3.30	4.01	0.60	8.58	7.98	4.06	4.06	1821
0.44	2.64	0.49	0.53	4.10	4.98	0.55	8.80	8.25	7.21	7.21	1839
1.28	0.08	0.69	2.17	4.22	5.13	0.43	5.05	4.62	0.90	5.72	2067
0.10	*5.32*	*0.19*	*0.09*	*5.70*	*6.93*	*0.30*	*6.56*	*6.26*	*5.03*	*5.03*	*1674*
0.00	1.78	0.19	0.65	2.62	3.19	0.38	5.75	5.37	2.54	4.15	1845
0.00	3.64	0.06	0.49	4.19	5.09	0.05	10.22	10.17	4.94	4.94	1604
0.54	5.28	0.24	0.33	6.39	7.77	0.70	8.17	7.47	6.09	6.09	1602
0.00	*2.58*	*0.29*	*0.57*	*3.44*	*4.18*	*1.29*	*9.38*	*8.09*	*4.29*	*4.29*	*1606*
0.00	2.86	0.14	0.42	3.42	4.16	0.35	6.65	6.30	9.28	9.28	1603
0.26	*0.58*	*0.37*	*0.62*	*1.83*	*2.22*	*1.75*	*9.16*	*7.41*	*2.32*	*2.32*	*1605*
0.00	2.06	1.44	0.22	3.72	4.52	0.26	15.50	15.24	3.93	3.93	1999
0.00	2.68	0.14	0.44	3.26	3.96	0.54	8.74	8.20	6.16	6.16	2003
0.00	*2.10*	*0.18*	*0.40*	*2.68*	*3.26*	*0.80*	*8.83*	*8.03*	*8.67*	*8.67*	*1609*
0.00	3.84	0.07	0.18	4.09	4.97	0.30	8.15	7.85	6.86	6.86	1400
0.34	2.58	0.08	0.39	3.39	4.12	0.75	12.95	12.20	4.37	4.37	1599

TABLE XIII. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **Synthetic Nitrogen Products Co., New York City.**[1]		
1617	Nitrophoska	15-30-15	North Haven
	Tenn. Copper & Chemical Corp., Lockland, Ohio.		
1664	Loma	6-10-4	Hamden
	I. P. Thomas & Son, Philadelphia, Pa.		
1998	Economy Fertilizer 3-12-3	3-12-3	Clintonville
1620	Long Island Special 4-8-7	4-8-7	Hamden
1754	I. P. Thomas 5-8-7	5-8-7	Milford
1638	Thomas Tobacco Grower	5-4-5	Unionville
1622	Tip Top 3-10-6	3-10-6	Unionville
1621	Truckers High Grade Guano 4-8-4	4-8-4	Milford
1611	7% Guano	7-6-5	Milford
1612	7% Guano	7-6-5	Highwood
1997	Victor Potash Fertilizer 2-8-5	2-8-5	Willimantic
	Triton Oil and Fertilizer Co., New York City.		
1667	Triton 4-8-4 Fertilizer	4-8-4	Milford
1666	Triton 5-8-7 Fertilizer	5-8-7	Milford
	Virginia-Carolina Chemical Co., New York City.		
1632	V-C Aroostook Potato Grower	5-8-7	New Britain
1628	V-C Fish and Potash Compound	2-9-3	New Britain
1637	V-C XXXX Fish and Potash	4-8-4	Guilford
	Wilcox Fertilizer Co., Mystic, Conn.		
1639	Wilcox Corn Special 3-10-4	3-10-4	*Sampled at factory*
1636	Wilcox High Grade Fish and Potash 4-8-4	4-8-4	Groton
2127	Wilcox High Grade Fish and Potash 4-8-4	4-8-4	Sampled at factory
1651	Wilcox Potato and Vegetable Phosphate 5-8-7	5-8-7	Norwich
1643	Wilcox Top Dresser 7-6-5	7-6-5	New London

[1] The first figure in the "grade" column represents "nitrogen," not ammonia.

Containing Nitrogen, Phosphoric Acid and Potash—Continued.

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In Nitrates.	In Ammonia.	Organic water-soluble.	Organic water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As Muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
...	....	....	....	15.14	18.41	0.01	30.65	30.64	14.27	14.27	1617
.18	3.78	0.50	0.41	4.87	5.92	0.79	10.99	10.20	4.03	4.03	1664
28	1.40	0.31	0.48	2.47	3.00	1.08	13.15	12.07	3.44	4.26	1998
68	0.12	1.42	0.35	3.57	4.34	1.10	9.13	8.03	7.53	7.53	1620
00	3.60	0.20	0.48	4.28	5.20	0.55	9.44	8.89	7.34	7.34	1754
.00	0.80	0.73	2.73	4.26	5.18	2.03	9.78	7.75	1.20	6.17	1638
00	1.78	0.19	0.60	2.57	3.12	1.15	11.45	10.30	5.82	6.16	1622
00	2.86	0.21	0.43	3.50	4.26	1.13	9.25	8.12	3.55	4.37	1621
60	4.48	0.00	0.86	5.94	7.22	0.55	7.56	7.01	4.19	4.65	1611
48	4.34	0.20	0.95	5.97	7.26	0.60	7.47	6.87	4.28	4.61	1612
.00	1.24	0.34	0.42	2.00	2.43	0.80	9.49	8.69	4.07	5.09	1997
1.46	0.80	0.50	0.74	3.50	4.26	0.75	9.43	8.68	3.97	3.97	1667
1.34	1.88	0.55	0.73	4.50	5.47	0.68	9.29	8.61	6.67	6.67	1666
0.00	3.10	0.72	0.57	4.39	5.34	0.50	8.85	8.35	7.41	7.41	1632
0.00	0.94	0.60	0.32	1.86	2.26	1.00	10.13	9.13	3.07	3.07	1628
0.00	2.34	0.62	0.28	3.24	3.94	0.95	8.61	7.66	4.12	4.12	1637
1.40	0.24	0.40	0.49	2.53	3.08	0.68	10.83	10.15	4.34	4.76	1639
1.08	0.22	0.97	0.64	2.91	3.54	0.63	8.82	8.19	3.32	4.07	1636
1.28	0.22	0.74	1.00	3.24	3.94	0.73	9.10	8.37	3.91	4.55	2127
1.26	1.46	0.69	0.59	4.00	4.86	0.49	8.86	8.37	7.09	7.09	1651
0.48	1.84	2.47	0.78	5.57	6.77	1.31	8.00	6.69	3.74	5.02	1643

TABLE XIII. ANALYSES OF MIXED FERTILIZERS

Station No.	Manufacturer and Brand.	Grade.	Place of Sampling.
	Sampled by Station: **Worcester Rendering Co., Auburn, Mass.**		
1647	Prosperity Brand Complete Dressing	6-6-4	Groton
1648	Prosperity Brand Corn and Grain Fertilizer	2-10-2	Groton
1650	Prosperity Brand Market Garden Fertilizer	5-8-7	Groton
1649	Prosperity Brand Potato and Vegetable Fertilizer	4-8-4	Groton
2002	Special Potato Fertilizer	4-6-10	Putnam
1912	Superior Top Dressing	8-6-6	Norwich
	Sampled by Purchaser. **Apothecaries Hall Co., Waterbury, Conn.**		
1711	Liberty Special Fertilizer for Fruit 7-8-6	7-8-6	Collinsville
	Armour Fertilizer Works, New York City.		
2018	Armour's 5-8-7 Fertilizer	5-8-7	J. L. Futtner, Silver Lane
2019	Armour's 5-3-5 Fertilizer	5-3-5	J. L. Futtner, Silver Lane
	Olds & Whipple, Inc., Hartford, Conn.		
1708	High Grade Potato and Vegetable Fertilizer	5-8-7	Hartford
1709	High Grade Potato and Vegetable Fertilizer	5-8-7	Hartford
	The Rogers & Hubbard Co., Portland, Conn.		
1483	5-8-7 Fertilizer	5-8-7	Beacon Falls
	Standard Wholesale Phosphate & Acid Works, Baltimore, Md.		
1768	4-8-4	4-8-4	Branford
1767	5-8-7	5-8-7	Branford
1766	5-10-5	5-10-5	Branford

CONTAINING NITROGEN, PHOSPHORIC ACID AND POTASH—*Concluded.*

Nitrogen.					Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
In Nitrates.	In Ammonia.	Organic water-soluble.	Organic water-insoluble.	Total.		Citrate-insoluble.	Total.	So-called "Available."	As Muriate.	Total.	
%	%	%	%	%	%	%	%	%	%	%	
48	3.16	0.81	0.56	5.01	6.09	0.83	7.40	6.57	4.94	4.94	1647
18	1.00	0.51	0.58	2.27	2.76	1.25	10.78	9.53	3.48	3.48	1648
.48	2.66	0.55	0.64	4.33	5.26	1.01	9.45	8.44	7.00	7.00	1650
.44	1.88	0.33	0.58	3.23	3.93	0.80	9.23	8.43	4.06	4.06	1649
66	5.04	0.36	0.50	6.56	7.98	0.60	6.86	6.26	6.39	6.39	1912
38	1.98	0.36	0.60	3.32	4.04	0.89	7.15	6.26	10.64	10.64	2002
	....	....	....	5.45	6.63	1.44	9.95	8.51	6.10	6.10	1711
	....	....	....	4.08	4.96	0.39	8.80	8.41	7.06	7.06	2018
	....	....	....	3.50	4.26	0.18	3.38	3.20	0.57	4.98	2019
	....	....	....	4.26	5.18	0.93	9.10	8.17	0.49	7.64	1708
	....	....	....	4.34	5.28	0.95	9.13	8.18	0.49	7.58	1709
	....	....	....	4.34	5.28	0.15	8.90	8.75	....	7.19	1483
	....	....	....	3.28	3.99	0.75	9.48	8.73	4.29	4.29	1768
	....	....	....	3.96	4.81	0.41	8.50	8.09	6.87	6.87	1767
	....	....	....	4.26	5.18	0.35	10.88	10.53	4.95	4.95	1766

TABLE XIV. SUMMARY OF DEFICIENCIES.

Manufacturer.	Number Samples.	Number Guaranties.	Number deficiencies in— Ammonia.	Avail. P_2O_5	Potash	Per cent of guaranties met.
American Agricultural Chemical Co.	43	129	2	5	4	91
Apothecaries Hall Co.	13	39	1	4	1	85
Armour Fertilizer Works	10	30	1	1	2	87
Associated Seed Growers, Inc.	3	9	0	0	0	100
Bartlett, F. A., Tree Expert Co.	1	3	0	0	0	100
Berkshire Chemical Co.	10	30	2	0	1	90
Bridge's Sons, Amos D., Inc.	2	6	0	0	0	100
Chittenden, E. D., Co.	4	12	0	0	0	100
C & R Sales Co.	1	3	0	0	0	100
Davey Tree Expert Co., Inc	1	3	0	0	0	100
Eastern States Farmers' Exchange	12	36	2	0	3	86
Essex Fertilizer Co.	6	18	0	2	1	89
Friedman Tobacco Products Corp.	1	3	0	1[1]	1	33
Frisbie, L. T., Co.	8	24	0	1	1	92
Grasselli Chemical Co.	1	3	1	0	0	67
International Agricultural Corp.	2	6	0	0	0	100
Lowell Fertilizer Co.	8	24	1	2	0	88
Maine Farmers' Exchange	3	9	0	0	0	100
Mapes Formula and Peruvian Guano Co.	14	42	0	0	1	98
Markham, A. G., & Co.	3	9	0	1	1	78
Millane Tree Expert Co.	1	3	1	0	0	67
New England Fertilizer Co.	6	18	0	0	1	94
Old Deerfield Fertilizer Co.	1	3	0	0	0	100
Olds & Whipple, Inc.	6	18	0	0	0	100
Parmenter and Polsey	2	6	0	0	0	100
Piedmont Mt. Airy Guano Co.	3	9	1	1	0	78
Platt, Frank S., Co.	2	6	0	0	0	100
Rackliffe Bros. Co.	2	6	0	0	0	100
Rogers & Hubbard Co., The	19	57	2	1	0	95

[1] Total P_2O_5.

TABLE XIV. SUMMARY OF DEFICIENCIES—*Concluded.*

Manufacturer.	Number Samples.	Number Guaranties.	Number deficiencies in— Ammonia.	Avail. P_2O_5	Potash	Per cent of guaranties met.
Royster, F. S., Guano Co.	4	12	1	1	1	75
Shoemaker, M. L., & Co.	4	12	1	1	0	83
Springfield Rendering Co.	5	15	0	0	0	100
Standard Wholesale Phosphate and Acid Works	10	30	2	2	3	77
Swift & Co.	1	3	0	0	0	100
Synthetic Nitrogen Products	1	3	0	0	1	67
Tennessee Copper and Chemical Corp.	1	3	0	0	0	100
Thomas, I. P., & Sons	9	27	0	0	2	93
Triton Oil and Fertilizer Co.	2	6	0	0	1	83
Virginia-Carolina Chemical Co.	3	9	0	1	0	89
Wilcox Fertilizer Co.	5	15	3	0	0	80
Worcester Rendering Co.	6	18	0	1	0	94
Totals	239	717	21	25	25	90

TABLE XV. SAMPLES SHOWING COMMERCIAL DEFICIENCIES.

Sta. No.	Brand.	Approximate deficiency in money value per ton.
1439	A. A. C. Aroostook Potato Manure	\$1.29[1]
1743	Apothecaries Hall Co. Liberty Double Strength	2.91
1526	*Essex Fish Fertilizer for All Crops*	1.15[1]
1278	Friedman Tobacco Dust Fertilizer	1.64
1451	Lowell Top Dressing 7-6-5	1.11
2223	Millane Shade Tree Food	1.93
1982	R & H Tunaker for Tobacco	1.93
2230	R & H Tunaker for Tobacco	2.57
1845	Standard Wholesale Acid and Phosphate Works, 5-4-5	6.58

[1] *Second sample not deficient.*

TABLE XVI. COMMERCIAL DEFICIENCIES FOR THE PERIOD 1921-1929.

Manufacturer.	Total number of samples.	Number equaling or exceeding guaranties in money value.	Per cent for 9 yr. period.	No. of samples for 1929.	Per cent for 1929.
American Agricultural Chemical Co.	390	375	96	43	98
Apothecaries Hall Co.	87	86	99	13	92
Armour Fertilizer Works	96	77	80	10	100
Atlantic Packing Co.	51	47	92[1]	0	100
Berkshire Chemical Co.	79	79	100	10	100
Bridge's, A. D., & Sons Co.	19	19	100	2	100
Chittenden, E. D., Co.	56	51	91	4	100
Clark, E. B., Seed Co.	37	34	92[1]	0	...
Eastern States Farmers' Exchange	93	78	84	12	100
Essex Fertilizer Co.	59	56	95	6	83
Frisbie, L. T., Co.	89	79	89	8	100
International Agricultural Corp.	63	57	90	2	100
Lowell Fertilizer Co.	92	82	89	8	88
Mapes Formula and Peruvian Guano Co.	118	117	99	14	100
New England Fertilizer Co.	68	65	96	6	100
Olds and Whipple, Inc.	57	57	100	6	100
Parmenter and Polsey	30	29	97	2	100
Piedmont-Mt. Airy Guano Co.	34	25	74	3	100
Rogers & Hubbard Co., The	132	127	96	19	89
Royster, F. S., Guano Co.	67	54	81	4	100
Shoemaker, M. L., & Co.	26	26	100	4	100
Springfield Rendering Co.	37	35	95	5	100
Standard Wholesale Acid and Phosphate Works	18	17	94[2]	10	90
Thomas, I. P., & Sons	41	41	100	9	100
United States Guano Co.	24	23	96	0	...
Virginia-Carolina Chemical Co.	60	56	93	3	100
Wilcox Fertilizer Co.	65	61	94	5	100
Worcester Rendering Co.	38	34	89	6	100
Totals	2058	1916	93	212	96

[1] No samples in 1929.
[2] For two years.

SPECIAL MIXTURES AND HOME MIXTURES.

Sixty-seven samples of mixed fertilizers have been examined for individuals, such samples in most cases being drawn by the persons interested. The Station is responsible only for the analyses of these materials as received.

Analyses are given in Table XVII.

VIII. MISCELLANEOUS FERTILIZERS, AMENDMENTS, WASTE PRODUCTS, ETC.

SHEEP MANURE, ETC.

Fifteen samples of Sheep manure and other farm manures were analyzed. All met or exceeded their guaranties for nitrogen, phosphoric acid and potash, except two which were slightly deficient in nitrogen. These shortages did not exceed 0.1 per cent.

Analyses are given in Table XVIII.

LIME.

Seven samples of agricultural lime have been examined for purchasers and analyses are given in Table XIX.

OTHER MISCELLANEOUS MATERIALS.

Analyses of various materials with remarks where necessary are given in Table XX.

COLLABORATIVE WORK.

The laboratory has continued to participate in the check meal program of the American Oil Chemists Society and in the check fertilizer program sponsored by the F. S. Royster Guano Company. This work aims to compare and improve methods of analysis and has involved the examination of 45 samples.

TABLE XVII. ANALYSES OF SPECIAL AND HOME MIXTURES.

Station No.	Manufacturer or Brand.	Place of Sampling.	Total Nitrogen.	Ammonia equivalent to total nitrogen.	Phosphoric Acid. Citrate-insoluble.	Phosphoric Acid. Total.	Phosphoric Acid. So-called "Available."	Potash. As Muriate.	Potash. Total.	Station No.
	Sampled by Station:		%	%	%	%	%	%	%	
1518	Home Mixture for Tobacco	L. B. Haas & Co., Hazardville	5.60	6.81	0.50	3.65	3.15	0.74	12.74	1518
1904	Home Mixture for Corn	Lester W. Lloyd, Suffield	3.84	4.67	....	9.67	....	4.88	4.88	1904
2161	Special Formula B	F. C. Gould, Silver Lane	4.77	5.80	4.10	12.60	8.50	0.78	6.28	2161
1640	Woodruff Home Mixed Fertilizer	S. D. Woodruff & Sons, Orange	3.07	3.73	0.30	8.40	8.10	7.12	7.12	1640
	Sampled by Purchaser:									
1235	Formula A	American Sumatra Tobacco Co., Bloomfield	6.02	7.32	0.92	5.18	4.26	....	5.00	1235
1231	"Drill" Fertilizer	American Sumatra Tobacco Co., Bloomfield	9.79	11.90	0.62	3.64	3.02	....	1.28	1231
1236	F. E. Fertilizer	American Sumatra Tobacco Co., Bloomfield	6.02	7.32	0.41	3.53	3.12	....	5.87	1236
1237	F. E. Fertilizer	American Sumatra Tobacco Co., Bloomfield	5.86	7.12	0.49	3.71	3.22	....	6.38	1237
1232	F. A. G. Fertilizer	American Sumatra Tobacco Co., Bloomfield	5.46	6.64	0.90	5.56	4.66	....	4.11	1232
1234	F. B. G. Fertilizer	American Sumatra Tobacco Co., Bloomfield	5.16	6.27	0.88	5.64	4.76	....	5.14	1234
1233	F. C. G. Fertilizer	American Sumatra Tobacco Co., Bloomfield	5.23	6.36	1.25	6.11	4.86	....	7.65	1233

TABLE XVII. ANALYSES OF SPECIAL AND HOME MIXTURES—*Continued.*

Station No.	Manufacturer or Brand.	Place of Sampling.	Total Nitrogen.	Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
					Citrate-insoluble.	Total.	So-called "Available."	As Muriate.	Total.	
	Sampled by Purchaser:		%	%	%	%	%	%	%	
889	Formula A	American Sumatra Tobacco Co., Bloomfield	6.08	7.39	1.17	5.36	4.19	....	6.13	889
890	Formula B	American Sumatra Tobacco Co., Bloomfield	6.08	7.39	1.63	3.06	1.43	....	7.57	890
9780	Special High Grade Tobacco Starter	P. J. Anderson, Windsor	7.90	....	0.53	4.80	4.27	....	0.80	9780
9781	Special High Grade Tobacco Starter	P. J. Anderson, Windsor	8.12	....	0.63	....	....	....	0.79	9781
9779	Special Home Mixture	P. J. Anderson, Windsor	4.88	5.93	0.33	4.05	3.72	....	7.12	9779
1678	Potato Fertilizer	Hatheway & Steane, Inc., Hartford	5.59	6.80	0.53	10.38	9.85	0.69	9.56	1678
1307	Special Tobacco Fertilizer, Hasting Farm	Consolidated Cigar Corp., Hartford	6.07	7.38	0.53	4.13	3.60	0.08	4.18	1307
1306	Special Tobacco Fertilizer, Hinsdale Farm	Consolidated Cigar Corp., Hartford	6.10	7.42	0.60	4.36	3.76	0.11	4.43	1306
1305	Special Tobacco Fertilizer, Huntting Farm	Consolidated Cigar Corp., Hartford	6.09	7.40	0.50	3.80	3.30	0.11	4.66	1305
1303	Special Tobacco Fertilizer, Kanter Farm	Consolidated Cigar Corp., Hartford	6.15	7.48	0.48	4.07	3.59	0.08	4.14	1303
1304	Special Tobacco Fertilizer, Myers Farm	Consolidated Cigar Corp., Hartford	6.06	7.37	0.50	4.29	3.79	0.09	4.42	1304
1302	Special Tobacco Fertilizer Shaker Farm	Consolidated Cigar Corp., Hartford	6.08	7.39	0.50	4.48	3.98	0.07	4.34	1302

TABLE XVII. ANALYSES OF SPECIAL AND HOME MIXTURES—*Continued.*

Station No.	Manufacturer or Brand.	Place of Sampling.	Total Nitrogen.	Ammonia equivalent to total nitrogen.	Phosphoric Acid. Citrate-insoluble.	Phosphoric Acid. Total.	Phosphoric Acid. So-called "Available."	Potash. As Muriate.	Potash. Total.	Station No.
	Sampled by Purchaser:		%	%	%	%	%	%	%	
1426	Special Tobacco Fertilizer, Spear Farm	Consolidated Cigar Corp., Hartford	5.93	7.21	....	4.00	....	....	4.20	1426
1427	Special Tobacco Fertilizer, Warner Farm	Consolidated Cigar Corp., Hartford	6.12	7.44	....	4.11	.....	....	4.17	1427
1301	Special Tobacco Fertilizer, Whitaker Farm	Consolidated Cigar Corp., Hartford	5.96	7.25	0.49	4.20	3.71	0.13	4.78	1301
1309	Special Tobacco Fertilizer, Winton Farm	Consolidated Cigar Corp., Hartford	6.09	7.40	0.37	4.06	3.69	0.11	4.21	1309
1308	Special Tobacco Fertilizer, Wolf Farm	Consolidated Cigar Corp., Hartford	6.19	7.53	0.55	4.43	3.88	0.11	4.28	1308
2129	Special Mixture Fertilizer, Higgins	Consolidated Cigar Corp., Hartford	5.24	6.37	0.35	3.85	3.50	0.54	5.76	2129
2130	Special Mixture Fertilizer, Stevenson	Consolidated Cigar Corp., Hartford	5.06	6.15	0.38	3.23	2.85	0.42	5.38	2130
2131	Special Mixture Fertilizer, Lata	Consolidated Cigar Corp., Hartford	5.69	6.92	0.73	4.93	4.20	0.40	6.57	2131
2132	Special Mixture Fertilizer, Bihl	Consolidated Cigar Corp., Hartford	5.28	7.08	0.68	4.45	3.77	0.36	7.08	2132
2133	Special Mixture Fertilizer, Jones	Consolidated Cigar Corp., Hartford	6.10	7.42	1.92	6.90	4.98	0.74	8.37	2133
2134	Special Mixture Fertilizer, Dickau	Consolidated Cigar Corp., Hartford	5.89	7.16	0.31	3.88	3.57	0.47	8.31	2134

TABLE XVII. ANALYSES OF SPECIAL AND HOME MIXTURES—*Continued.*

Station No.	Manufacturer or Brand.	Place of Sampling.	Total Nitrogen.	Ammonia equivalent to total nitrogen.	Phosphoric Acid. Citrate-insoluble.	Phosphoric Acid. Total.	Phosphoric Acid. So-called "Available."	Potash. As Muriate.	Potash. Total.	Station No.
	Sampled by Purchaser:		%	%	%	%	%	%	%	
2135	Special Mixture Fertilizer, House	Consolidated Cigar Corp., Hartford	6.28	**7.64**	1.38	6.10	**4.72**	0.66	**7.81**	**2135**
2136	Special Mixture Fertilizer, Keeney	Consolidated Cigar Corp., Hartford	5.66	**6.88**	0.42	3.93	**3.51**	0.48	**8.33**	**2136**
9818	Eastern States 12-24-12	Eastern States Farmers' Exchange, Springfield, Mass.	11.02	**13.40**	1.62	23.70	**22.08**	0.19	**12.07**	**9818**
9819	Eastern States 10-20-15	Eastern States Farmers' Exchange, Springfield, Mass.	9.96	**12.11**	1.68	20.90	**19.22**	0.19	**13.69**	**9819**
9820	Eastern States 10-30-10	Eastern States Farmers' Exchange, Springfield, Mass.	9.40	**11.43**	1.85	30.20	**28.35**	0.04	**10.76**	**9820**
1555	Fertilizer	L. B. Haas & Co., Inc., Hazardville	5.50	**6.69**	....	3.65	....	0.57	**11.65**	**1555**
1831	Olds & Whipple Fertilizer, Form No. 1	I. Kaffenburgh & Sons, Inc., Hartford	7.11	**8.64**	0.18	3.65	**3.47**	0.62	**11.86**	**1831**
1832	Olds & Whipple Fertilizer Form. No. 2	I. Kaffenburgh & Sons, Inc., Hartford	7.73	**9.40**	0.33	3.73	**3.40**	0.70	**14.31**	**1832**
1833	Olds & Whipple Fertilizer, Form. No. 3	I. Kaffenburgh & Sons, Inc., Hartford	6.30	**7.66**	0.38	3.28	**2.90**	0.62	**10.47**	**1833**
1834	Olds & Whipple Fertilizer, Form. No. 4	I. Kaffenburgh & Sons, Inc., Hartford	6.60	**8.02**	0.33	3.40	**3.07**	0.56	**11.89**	**1834**

TABLE XVII. ANALYSES OF SPECIAL AND HOME MIXTURES—*Continued*.

Station No.	Manufacturer or Brand.	Place of Sampling.	Total Nitrogen.	Ammonia equivalent to total nitrogen.	Phosphoric Acid. Citrate-insoluble.	Phosphoric Acid. Total.	Phosphoric Acid. So called "Available."	Potash. As Muriate.	Potash. Total.	Station No.
	Sampled by Purchaser:		%	%	%	%	%	%	%	
1909	Rogers & Hubbard R 4 Mixture	I. Kaffenburgh & Sons, Inc., Hartford	6 22	7 56	0 33	7 99	7.66	1.02	20 49	1909
1910	Rogers & Hubbard R 5 Mixture	I. Kaffenburgh & Sons, Inc., Hartford	6 84	8 32	0 20	7 71	7.51	1 06	22.40	1910
2071	Rogers & Hubbard Special Mixture	Karl C. Kulle, Suffield	5 06	6.15	0 14	4 51	4 37	0.43	8.93	2071
842	Consolidated Special Fertilizer	Olds & Whipple, Inc., Hartford	6 27	7 62	0.63	4 67	4 04	....	4.07	842
888	Climax Fertilizer 5-3-5	The Rogers & Hubbard Co., Middletown	4.46	5 42	0 54	4 07	3.53	....	5 60	888
848	Oats and Top Dressing Fertilizer, 10-3-8	The Rogers & Hubbard Co., Middletown	8 34	10 14	2.33	8 78	6.45	....	8.97	848
750	Tobacco Grower Brand	The Rogers & Hubbard Co., Middletown	5 18	6.30	0 29	3 97	3.68	....	5.50	750
1680	Shoemaker's Swift-Sure Fertilizer, Car 58355	American Sumatra Tobacco Co. Bloomfield	3 47	4 22	1 55	11.10	9.55	0.23	0.57	1680
1691	No. 1 Mixture with Manure	Silberman & Kahn, Hartford	6.55	7.96	0.40	4 43	4 03	0.32	6.71	1691
1692	No. 2 Mixture with Stems	Silberman & Kahn, Hartford	7.33	8 91	0 30	4.88	4 58	0.37	6.95	1692
1693	*No. 3 Mixture with Stems*	Silberman & Kahn, Hartford	7 07	8.60	0.40	5.08	4.68	0.20	1.21	1693
1859	Old Land Fertilizer	Silberman & Kahn, Hartford	6 95	8.45	0.18	5.00	4 82	0.35	4.19	1859
1860	"New Land" Fertilizer	Silberman & Kahn, Hartford	6 57	7 99	0 18	4 63	4 45	0 32	5.72	1860

TABLE XVII. ANALYSES OF SPECIAL AND HOME MIXTURES—*Concluded.*

Station No.	Manufacturer or Brand.	Place of Sampling.	Total Nitrogen.	Ammonia equivalent to total nitrogen.	Phosphoric Acid.			Potash.		Station No.
					Citrate-insoluble.	Total.	So-called "Available."	As Muriate.	Total.	
	Sampled by Purchaser:		%	%	%	%	%	%	%	
1848	O & W Fertilizer	Silberman & Kahn, Hartford	2.86	3.48	0.28	7.50	7.22	3.72	3.72	1848
2118	Fertilizer	Silberman & Kahn, Hartford	5.91	7.19	0.56	4.19	3.63	0.15	4.24	2118
1895	Olds & Whipple Special Mixture No. 1	M. Silverberg, Ellington	8.18	9.95	....	1.65	....	0.57	18.61	1895
1896	Olds & Whipple Special Mixture No. 2	M. Silverberg, Ellington	8.14	9.90	....	1.70	....	0.27	17.01	1896
1652	Olds & Whipple 5-8-7 Fertilizer with KCL	H. E. Wells, Warehouse Point	4.24	5.15	1.07	9.25	8.18	7.35	7.35	1652
1653	Olds & Whipple Grass Fertilizer 6-6-4	H. E. Wells, Warehouse Point	4.90	5.96	0.95	7.58	6.63	5.02	5.02	1653
1654	Olds & Whipple Special Fertilizer No. 3	H. E. Wells, Warehouse Point	8.13	9.88	0.10	7.94	7.84	0.68	13.49	1654
1655	Olds & Whipple Special Fertilizer No. 4	H. E. Wells, Warehouse Point	7.93	9.64	0.10	8.94	8.84	0.60	14.72	1655
1874	Olds & Whipple Special Fertilizer Mixture No. 12	H. E. Wells, Warehouse Point	....	....	....	....	....	0.66	14.13	1874
2229	Dahlium (for dahlias) Plantspur Products Co., Ridgefield, N. J.	C. Lewis Alling, West Haven	4.19	....	0.96	3.98	3.02	3.16	3.16	2229

TABLE XVIII. ANALYSES OF

Station No.	Manufacturer or Brand.	Place of Sampling.
	Sampled by Station.	
1494	AAC Pulverized Sheep and Goat Manure. American Agricultural Chemical Co., New York City	Roodner Grain Co., So. Norwalk
1563	Sheep and Goat Manure. Armour Fertilizer Works, New York City	F. A. Bartlett Tree Expert Co. Stamford
1392	Berkshire Sheep Manure. Berkshire Chemical Co., Bridgeport, Conn.	C. Buckingham & Co., Southport
1404	Par Plus Brand Reinforced Sheep Manure. A. H. Case & Co., Buffalo, N. Y.	S. D. Woodruff & Son, Orange
1579	Corenco Sheep Manure. Consolidated Rendering Co., Boston, Mass.	Knowles & Lombard Co., Guilford
1442	Davey Shredded Cattle Manure. Davey Tree Expert Co., Kent, Ohio	R. E. Landis, Sound Beach
1416	"Sheep's Head" Pulverized Sheep Manure. National Guano Co., Aurora, Ill.	Cadwell & Jones, Hartford
1464	Favorite Sheep Manure. Olds & Whipple, Inc., Hartford	Sampled at factory
1477	Groz-It Pulverized Sheep Manure. Pacific Manure & Fertz. Co., San Francisco, Cal.	F. T. Blish Hardware Co., So. Manchester
1533	Premier Brand Poultry Manure. Premier Poultry Manure Co., Chicago, Ill.	Lightbourn & Pond, New Haven
1534	Premier Brand Sheep Manure. Premier Poultry Manure Co., Chicago, Ill.	Lightbourn & Pond, New Haven
1417	Wizard Brand Cattle Manure. Pulverized Manure Co., Chicago, Ill.	S. P. Strople, New Britain
1418	Wizard Brand Pulverized Sheep Manure. Pulverized Manure Co., Chicago, Ill.	S. P. Strople, New Britain
2000	Royster's Sheep and Goat Manure. F. S. Royster Guano Co., Baltimore, Md.	F. H. Woodruff & Sons, Milford
2159	Sheep and Goat Manure. I. P. Thomas & Sons, Philadelphia, Pa.	Ira W. Beers, Hamden

SHEEP MANURE, ETC.

Total Nitrogen.	Ammonia equivalent to total nitrogen.		Phosphoric Acid.				Potash.		Station No.
			Available.		Total.				
	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	
%	%	%	%	%	%	%	%	%	
1.52	1.85	1.50	....	....	1.00	0.50	3.08	2.00	1494
1.30	1.58	1.50	....	....	1.25	1.00	3.11	2.00	1563
2.14	2.60	2.18	1.60	1.00	1.80	....	2.91	2.00	1392
2.66	3.23	2.25	2.65	0.75	3.30	1.50	2.33	1.50	1404
1.50	1.82	1.50	....	....	1.25	0.50	3.08	2.00	1579
1.96	2.38	1.20	....	....	1.39	1.00	2.15	1.00	1442
2.20	2.67	2.73	1.68	1.00	1.83	1.25	3.33	2.00	1416
1.38	1.68	1.65	....	....	1.14	0.75	3.07	2.50	1464
1.61	1.96	1.80	....	....	0.95	0.75	3.35	3.00	1477
5.64	6.86	6.00	2.82	2.50	3.05	2.75	1.34	1.30	1533
1.84	2.24	2.00	0.88	0.80	1.08	1.00	1.85	2.00	1534
2.01	2.44	2.10	1.05	1.00	1.30	....	1.55	1.00	1417
1.90	2.31	2.43	1.73	1.25	1.88	....	3.44	2.00	1418
1.37	1.67	1.50	1.40	1.00	1.55	....	3.24	2.00	2000
1.42	1.73	1.50	....	....	1.23	1.00	3.59	2.00	2159

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TABLE XIX. ANALYSES OF

Station No.	Manufacturer or Brand.	Sampled by
	Farnam Cheshire Lime Co., Farnams, Mass.	
1830	Lime	John F. Luddy, Hazardville
	Lee Lime Co., Lee, Mass.	
2055	Hydrated Lime	Woodbury Co-operative Assoc., Inc., Woodbury
	Miller Lime Co., West Stockbridge, Mass.	
2056	Hydrated Lime	Woodbury Co-operative Assoc., Woodbury
	New England Lime Co., Canaan, Conn.	
1772	Hydrated Lime	T. R. Swanback, Windsor
	Manufacturer Unknown.	
410	*Burned Agricultural Lime*	*Ira W. Beers, Hamden*
1363	Limestone	Robt. Coe, Durham
1501	Lime	Chas. D. Lewis, Hartford

LIMESTONE, ETC.

Chemical Analysis.						Mechanical Analysis.					Station No.
CaO).	Magnesia (MgO).										
Guaranteed.	Found.	Guaranteed.	Total Oxides.	Insoluble in acid.	20 mesh.	40 mesh.	50 mesh.	80 mesh.	100 mesh.		
%	%	%	%	%	%	%	%	%	%		
....	0.68	....	67.96	....	92.5	62.5	36.5	17.5	12.5	**1830**	
....	30.35	....	77.74	....	97.5	91.0	57.5	19.0	6.5	**2055**	
....	2.63	....	62.24	....	....	....	....	....	....	**2056**	
....	31.35	....	76.96	....	98.9	96.6	89.3	61.1	16.9	**1772**	
....	28.03	....	68.93	....	89.5	43.0	33.0	16.0	15.5	**410**	
....	0.54	....	53.48	....	92.5	76.0	64.0	53.5	49.0	**1363**	
....	1.26	....	34.48	....	....	....	....	....	....	**1501**	

TABLE XX. MISCELLANEOUS MATERIALS.

No.	Material	Nitrogen.	Phosphoric acid.	Potash.	Remarks.
		%	%	%	
2068	Acid Phosphate ?..	....	3.20	0.17	Much CO_2. No water sol. carbonate Not leached ashes. Probably limestone.
1242	Bone meal	....	....	....	No foreign material detected.
1591	Bone meal.......	....	....	....	For identification.
571	Cattle manure	2.75	0.89	0.99	Moisture 13.93%.
1207	Chicken manure ..	2.36	3.52	1.50	Moisture 21.52%.
1208	Chicken manure ..	0.90	1.18	0.48	Moisture 73.70%.
887	Cotton hulls	0.58	....	....	Ash 2.80; fibre 35.93.
517	Cotton waste	1.45	0.59	1.05	....
1479	Fertilizer 5-4-5 ...	....	....	....	Appeared to contain castor pomace and cottonseed meal as source of organic nitrogen. Chlorine 1.03%
210	Fertilizer	....	3.95	....	Avail. P_2O_5 3.82%; moisture 6.38% Referee sample.
211	Fertilizer	....	3.24	5.15	Avail. P_2O_5 2.91%; moisture 6.25% Referee sample.
9838	Fertilizer	....	....	....	No salt (NaCL) found.
1019	Fertilizer	....	....	14.10	Check sample. 13.94% by alternat A. O. A. C. method.
913	Fertilizer	4.14	7.97	6.25	....
1557	Fertilizer	5.06	2.05	10.96	....
1556	Fertilizer	5.19	2.05	10.99	....
1960	Fertilizer	5.90	3.47	7.85	....
387	Fertilizer	5.78	5.78	5.98	....
1387	Fish, dry, ground..	8.49	....	....	Trace of ammon. sulphate crysta NH_3 0.18%. Probably accidental contamination.
2150	Material for identification	....	.....	56.07	Muriate of potash. Chlorine much sulphate trace, nitrate none.
2078	Material for identification	14.76	....	11.36	Nitrate of potash-soda.
1296	Muck	....	....	....	Moisture 4.94%: ash 87.00%; organi and volatile 8.06%.
757	Nitrate of Soda ?..	8.82	6.16	0.64	Not nitrate of soda. Probably mixture of nitrate of soda and aci phosphate.
1847	Nitrophoska No. 3	....	....	....	CaO 0.54%; MgO 0.10%.
487	Poultry Manure ...	5.04	1.93	1.24	Dry, pulverized.
1346	Sewage Sludge ...	0.81	0.28	0.07	Water 56.34%; ash 16.43%; organi and volatile 27.23%.
1347	Sewage Sludge ...	0.70	0.26	0.04	Water 30.00%; ash 52.50%; organi and volatile 17.50%.
1348	Sewage Sludge ...	0.75	0.42	0.05	Water 24.50%; ash 61.96%; organi and volatile 13.54%.
1488	Sewage Sludge ...	1.08	0.54	0.07	Water 45.80%; ash 31.31%; organi and volatile 22.89%.

TABLE XX. MISCELLANEOUS MATERIALS—*Concluded.*

No.	Material	Nitrogen.	Phosphoric acid.	Potash.	Remarks.
		%	%	%	
1663	Sewage Sludge ...	1 92	....	....	Water 4.83%; ash 40.50%; organic and volatile 54.67%.
1300	Sheep Manure	....	....	....	Some acid phosphate present; also limestone and shell; trace of ground bone.
9811	Sheep Manure	....	....	....	Appeared to be genuine. No ammonia sulphate detected.
9813 9814	Soils	....	....	....	*Ether extract of soils yellow and* fluorescent. Ether residue had appearance and consistency of vaselene. Soils impregnated with mineral oil or grease.
2069	Soil or Humus	0 32	0 10	0.12	Water 27.28%; ash 58.18%.
656	Tankage	3 15	5 94	....	....
907	Tankage	8 33	11 08	....	Trace of mineral phosphate.
9805	Tankage	3 92	15 75	....	Appeared to be genuine. No ammonia salts detected. Much bone and meat present.
1484	Tobacco dust	0 78	0 35	0 93	....
1386	Tobacco stems.....	1.18	0 70	3 59	....

CHLORINE IN FERTILIZER MATERIALS.

Tobacco growers desire to avoid chlorine so far as possible in their fertilizer mixtures and are therefore concerned with the chlorine content of their raw materials. Data obtained in the last two years as well as some obtained earlier are summarized in Table XXI.

Chlorine was extracted with hot water as directed in the method for water-soluble potash in mixed fertilizers, omitting ammonia and ammonium oxalate, and determined volumetrically.

TABLE XXI. CHLORINE IN SOME FERTILIZER MATERIALS.

Material	No. of Samples Tested	Chlorine, Cl., per cent. Range	Average
Ammonium phosphate	2	trace	....
Ammonium sulphate	13	none to 1.4	....
Blood, dried	2	0.3 to 1.4	0.80
Bone, ground	12	trace to 1.2	0.25
Calcium nitrate	1	none	....
Calurea	2	none	....
Castor pomace	4	trace to 0.1	0.06
Cottonseed meal	4	trace	....
Cottonhull ashes	..	0.2[1]	....
Cow manure (72% water)	..	0.1[1]	....
Fish scrap	48	0.1 to 0.7[2]	0.25
Horse manure (66% water)	..	0.1[1]	....
Linseed meal	4	none	....
Potassium carbonate	22	trace to 1.2	0.11
Potassium nitrate	6	0.6 to 1.5	0.98
Potassium sulphate	20	trace to 4.6	2.22
Potassium-magnesium sulphate	2	1.5 to 2.7	1.90
Sodium nitrate	12	0.1 to 1.6	0.56
Sodium-potassium nitrate	6	trace to 0.8	0.41
Superphosphate (acid phosphate)	4	trace	....
Tankage	12	trace to 1.1	0.40
Tobacco stems (20% water)	..	0.5[1]	....
Wood ashes	..	0.5[1]	....

[1] Taken from a compilation by Dr. Jenkins in 1922.
[2] Conn. Exp. Sta., Bull. 250, p. 43, 1923. This is excluding two samples which were found to contain 2.6 and 3.3% of chlorine and which are extraordinary.

ADDENDA, ETC.

Page 11, To the brands registered by Apothecaries Hall Co. add, Tobacco Starter.

Page 14, Frisbie's Top Dresser, 8-6-5, should read 8-6-6.

Page 17, The Rogers & Hubbard Co., 5-10-15 Fertilizer, should read 5-10-5.

Page 18, to the brands registered by F. S. Royster Guano Co. add, Royster's Trucker's Delight.

Page 18, to the brands registered by M. L. Shoemaker & Co. add, "Swift-Sure" Tobacco Starter, 4-10-0.

Bulletin 309 December, 1929

FIFTY YEARS' INDEX

1877-1927

E. H. JENKINS

Connecticut
Agricultural Experiment Station
New Haven

The bulletins of this station are mailed free to citizens of Con
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FOREWORD

In preparing this general index to the annual reports of the Connecticut Agricultural Experiment Station for the fifty years, 1877-1927, only matters of permanent interest and value have been included. For example, the details of the reports on fertilizers and feeding stuffs and other items of passing interest, such as descriptions of well known chemical methods, are omitted.

Three special indexes have been printed as follows: Index to Reports on Foods and Drugs, 1896-1914, Bulletin 187; Index to Reports on Foods and Drugs, 1915-1925, Bulletin 284, and the General Index to Reports of the State Entomologist, 1901-1925, Bulletin 281. These are referred to by title and page, but the details are omitted. The botany department is preparing an index of hosts and fungi and these are not in the general index, but the more important botanical papers are included.

Bulletins of Immediate Information are listed, but their subject matter is not indexed. The acts of the general assembly concerning the station's duties and its buildings and grounds are included, but the general maintenance appropriations are not cited.

Following the general index are (a) an index to analyses of miscellaneous materials, (b) a list of the personnel, (c) list of all bulletins issued since the founding of the station, and (d) lists of all publications, including journal papers, arranged according to departments.

CONTENTS

Page

General index to the annual reports 113

Index to analyses of miscellaneous materials with reference to manurial value 123

Members of the board of control and employees of the station 125

List of station bulletins 129

Publications of the departments:

Analytical chemistry 135

Biochemistry 138

Botany 154

Entomology 164

Forestry 178

Plant breeding 180

Soils 183

Tobacco substation 184

GENERAL INDEX TO ANNUAL REPORTS

Adams Act, portion given to station ..... '07-'08, x
Agrostis, fine *vs.* coarse ..... '87, 177
vulgaris ..... '89, 247
Albuminoids in feeding stuffs, determination of ..... '79, 104
Alfalfa, notes on yield of ..... '11, 237
observations on ..... B. 192, '17
Aliquotimeter, description of ..... '89, 189
Anthomyia ceparum ..... '94, 139
Apiaries, inspection of ..... '26, 192
Apple and thorn skeletonizer ..... '22, 247
bibliography of ..... '22, 263
chief insects attacking ..... '21, 209
orchards, general treatment of ..... '25, 102
pomace, analysis and food value of ..... '81, 86
results of various summer sprays ..... '09-'10, 583; '11, 358
Asiatic beetle ..... '26, 257
Aspidiotus perniciosus ..... '95, 192, 194; '97, 314
Asterodiaspis quercicola ..... '95, 193
Asters, nematodes disease of ..... '92, 45
Atropos divinatoria ..... '00, 321
Azotometer, a modified ..... '79, 125
Babcock apparatus, act concerning testing of ..... '01, viii, 279
tests of ..... '02, 423; '03, 439; '04, 448; '05, 343; '16, 429; '20, 351
method as a basis for payment in cream-gathering creameries '94, 214
of determining butter fat in milk ..... '94, 209
Bark beetle, fruit ..... '96, 240
Beekeeping for Connecticut ..... '17, 423
Beet sugar production ..... '77, 101; '78, 124
Berries, anatomy of edible ..... '02, 288
Bibliography concerning apple skeletonizer ..... '22, 263
European mites ..... '23, 124
genetics and morphology of endosperm characters of maize ... '25, 513
inbreeding and cross-breeding effects on development ..... '18, 5
raspberry fruit worm ..... '23, 89
Biochemical department, publications from ..... '18, xv; '22, 170; '25, 209
Birch leaf skeletonizer, biology of ..... '26, 395
Blister rust of white pine in Connecticut ..... '18, 428
Book lice ..... '00, 321
Botanical department, publications from ..... '22, 169; '25, 210
Bordeaux mixture, first experiments with ..... '89, 174
Brown tail moth ..... B. 153, '06
Bulletins of immediate information Nos. 28-47 (at end of) '23
Nos. 48-50 (at end of) '24
Nos. 51-54 (at end of) '25
Nos. 55-60 (at end of) '26
Butter, act concerning adulteration of ..... '96, 70
imitation of ..... '86, 131
analyses of ..... '91, 122; '92, 130; '97, 323
methods of analyses of ..... '86, 131

NOTE. Numerals preceded by the letter B refer to the more important station bulletins which were published before all bulletins were included in the annual reports. The letter T refers to bulletins published in the tobacco substation series, which were bound at the back of the annual reports, but were not paged with them.

Cabbage and allied crops, insects attacking .... B. 190, '16
Candy, act concerning adulteration of .... '96, 75
Canker worm, banding trees to protect from .... '00, 312
Carnations, a disease of .... '97, 175
    tests of fertilizers for .... '96, 225; '97, 293; '99, 226; '00, 301
Cauliflower, leaf miner of .... '95, 204
Cecidomyia tritici .... '95, 191
Celery, leaf-spot and leaf-blight, prevention of .... '97, 167
Cereal breakfast foods, types, composition and value .... '17, 17
Cheese, analyses of .... '92, 157
Chess, *see Darnel*
Chestnut bark disease, *Eudothe* or *Diaporthe parasitica* .... '07-'08, 879
    blight poisoning, so-called .... '14, 30
    in Connecticut .... B. 154, '06
    timber, effect of cutting out infected .... '15, 488
    top grafting of .... '98, 276; '99, 239; '00, 307
Cherries and plums, various summer sprays on .... '11, 398
Citheronia regalis .... '89, 178
Clark field, purchase of .... '05, 5
Clover hay caterpillar .... '00, 315
    seed in the Connecticut market .... B. 160, '08
Clay, on some properties of .... '77, 71
Coal ashes and peat as soil for forcing house crops .... '96, 205
Cocoa nut, anatomy of the fruits of .... '01, 208
Coelodasys unicornis .... '89, 179
Coleothrips 3-fasciata .... '89, 180
Columbine leaf miner .... '94, 145
Commercial feeding stuffs, report on .... '26, 491
Conglutin .... '95, 288
Cooley system *vs.* De Laval separator for gathering cream .... '93, 145
Corn, better seed of, in Connecticut .... '07-'08, 397
    bibliography on self and cross fertilization .... '16, 346
    breeding, practical use of Mendelism in .... '07-'08, 407
    contribution to chemical statistics of .... '87, 118
    crossing, methods and effects of .... '25, 153
    description of tests of varieties of .... '23, 384
    distance of planting, on quantity and quality of crop, effect of .. '89, 9, 219
    experiments on inheritance in .... B. 188, '15
    genetics and morphology of some endosperm characters of .... '25, 513
    growth of, continuously on the same land ..... '91, 139; '92, 122; '93, 286; '94, 245; '95, 216; '96, 335
    hilling *vs.* drilling on quantity and quality of crop of .... '90, 183
    improvement of, by selection in self-fertilized lines .... '24, 349
    in Connecticut .... B. 152, '06
    in Connecticut .... '24, 382
    inheritance in .... '11, 407
    kernel analysis of .... '93, 301
    leaf miner of .... '94, 143
    plant and seed selection in .... '13, 353
    proteids of .... '91, 136
Cotton seed, anatomy with reference to microscopic examination .. '03, 180
    meal, trade in .... B. 170, '12
Cows, observations on feeding in Connecticut .... '81, 90
Cream, and the products of churning, analyses of .... '91, 121
    determination of by Babcock method .... '91, 115
    Cooley system *vs.* separator for gathering .... '93, 145
Cucumbers, first generation crosses of .... '16, 319
    in greenhouse, fertilizers for .... '96, 226

Currants, tests of various summer sprays on .... '11, 405
Darnel and chess, anatomy and microscopic identification of the fruits of .... '03, 165
Desiccator for gases .... '89, 184
Diabetic foods .... '13, 1
analyses of .... '26, 312
Diaspis rosae .... '98, 273
Diastase, chemical nature of ....'94, 192; '95, 233
Drosophila flaveola .... '95, 204
Drugs and medicines, act concerning adulterations of .... '96, 78
report on .... '26, 363
Dry rot fungus .... '06, 336
Drying in hydrogen, apparatus for .... '89, 187
oven .... '89, 195
Dusting *vs.* spraying of apples and peaches ....'21, 209; '22, 229; '24, 293
summary of five years work on .... '24, 293
Ecpantheria scribonia .... '89, 179
Edestan, a derivative of edestin .... '00, 392
Edestin, a hydrolytic derivative of .... '00, 388
compounds with alkalies .... '00, 399
Elm beetle ....'95, 208; '98, 270
wooly scale of .... '99, 241
Entomological department, publications ....'22, 175; '25, 210, 217; '26, 162
reports, 1901-1925, index of .... '25, 659
European corn borer .... '26, 239
Fat in cream, determination of by Babcock method .... '91, 115
feeding stuffs, comparison of solvents for .... '89, 250
methods of determining .... '86, 127
milk, determination by Babcock method .... '91, 107
Feeding stuffs, act concerning (see also Food Law '00, 107) ...... '00, 110
artificial digestion of .... '85, 43
compilation of analyses of American..'79, 132; '83, 90; '84, 113; '87, 183; '88, 89
weight of one quart of ....'04, 413; '06, 197; '07-'08, 189
Fertilizer, complete analysis of a .... '84, 89
Fertilizers, acts concerning ....'78, 126; '81, 116; '82, 11; '94, 3
for forcing house crops, use of '95, 75; '96, 205; '97, 278; '99, 219; '00, 298
on sampling of .... '84, 90
sold in Connecticut, quantity of .... '94, 72
explanation of valuation .... '14, 45
Fire blight .... '94, 113
Fires, see *forest*
Fir mite .... '94, 140
Fodders and feeds, average composition of in Conn. (1878-1913) .. '13, 341
Food and drug products, examination of .... '26, 363
index to reports on, 1896-1914 ....B. 187, '15
1915-1925 .... '26, 113
laws of Connecticut ....'07-'08, 121
products, act concerning ....'95, xv, 303
Foods, analyses of common .... '26, 293
for diabetics .... '26, 313
oils and fats, composition and food value .... '17, 199
Forage garden of the station .... '87, 163
Forcing house, crops, use of commercial fertilizers for......'95, 75; '96, 205; '97, 278; '99, 219; '00, 298
description of .... '96, 229
use of artificial soil for .... '95, 91
Forestation, act concerning .... '01, 362

Forest fires, report of........'06, 389; '09-'10, 777; '12, 457; '13, 420; '15, 195; '16, 379; '20, ix; '21, 10
plantations at Rainbow, description and map of.............. '12, 471
plantings in Connecticut ....'07-'08, 242; '12, 485
Rainbow, guide to .... '24, 103
survey of Litchfield County ....B. 162, '09
state .... '15, 197
town of Redding .... '16, 383
working plan for Portland state .... '13, 393
Forests, State ....'02, 469; '12, 462
additions to .... '06, xvi
descriptions of .... '06, 386
notice of .... '05, 5
plantations in ....'07-'08, 242; '12, 471
Forester, act appointing .... '01, viii
report of State ....'06, 369; '12, 455; '16, 389
Station, '01, 353; '02, 468; '07-'08, 211; '09-'10, 775; '12, 466; '15, 193 '16, 379
Forestry in Connecticut, need of .... '23, 133
Fruit census of Connecticut .... '02, 432
Fungicides, analyses and inspection of.............'22, 147; '23, 368; '25, 143
and their application ....'90, 99, 104
composition and use ....B. 102, '90; B. 111, '92; B. 125, '98
Fungous disease and their treatment ....B. 115, '93
literature of ....'93, 253; '97, 182; '00, 255; B. 118, '94
Gasoline, analyses of .... '20, 280
Genetics department, publications of .... '25, 210
Globulin, effect of acid on solubility in salt solution .... '96, 369
of English walnut, American black walnut and the butternut.. '02, 455
solubility in salt solution .... '02, 464
Grass gardening .... '90, 162
Grasses and other forage plants of salt marshes of Connecticut.... '89, 233
classification and names of..................................B. 93, '87
composition of some Connecticut .... '88, 100
some Connecticut .... '87, 100
yield and composition of in 1888 and 1889 .... '89, 246
Greenhouse, construction of .... '94, xv
Gipsy moth work .... '26, 199
Haltica marevagans ....'99, 244
Hatch act for benefit of Station .... '88, 1
Hemp seed, anatomy of with reference to microscopic examination '03, 175
Heteroecious rusts of Connecticut with peridermium in aecial stage ....'07-'08, 369
Honey, method of examination .... '88, 108
Honeysuckle, scale on .... '95, 194
Horn and hoof, agricultural value of .... '86, 80
Hungarian grass, availability of nitrogen in various forms by .... '99, 204
Hydrogen generator .... '89, 181
Inbreeding and cross-breeding on development, effects of .... '18, 5
Index of entomological reports, 1901-1925 .... '25, 661
insects mentioned in report of 1926 .... '26, 281
reports on foods and drugs, 1896-1914 ....B. 187, '15
1915-1925 .... '26, 113
Insecticides, recent developments in the use of .... '22, 163
Insect collection .... '26, 166
Insects, attacking cabbage and allied crops ....B. 190, '16
injuring stored food products ....B. 195, '17
mentioned in 1926, index of .... '26, 281
Insecticides, preparation and use ....B. 126, '98
inspection and analyses ....'23, 147, 368; '25, 143

Iron tubes for nitrogen determination .... '77, 101
Japanese beetle .... '26, 244
Jodlbauer's modification of the Kjeldahl method .... '87, 126
Lady beetles of Connecticut, some common ....B. 181, '14
Legumin ....'95, 262; '97, 365
  in various seeds .... '97, 324
Legumelin .... '97, 365
Lettuce grown in forcing house and composition of..'95, 93; '99, 224; '00, 298
Lice of apple and cherry trees .... '94, 140
Lily stalk borer .... '97, 317
Lima beans, downy mildew, *Phytophthora Phaseoli*........'89, 167; '97, 159; '98, 236; '05, 278
Lime, adjusting soil reaction by use of .... '26, 81
  influence on effect of fertilizers .... '80, 60
Lockwood, W. R., bequest to Station ....'00, xii, xiv
  field, first work on ....'01, xi, 357
    addition to .... '05, 5
  planting experiments ....'07-'08, 213
Madia seed, anatomy with reference to microscopic exam. of...... '03, 192
Maize, inheritance in ....B. 167, '11
  see Corn
Malt, proteids of .... '95, 239
Manure from the sea ....B. 194, '17
Meadow, experiment in top dressing .... '20, 351
Meat extracts, etc., bibliography of ....'07-'08, 606
Melons, downy mildew or blight of .... '04, 329
  fractional fertilization as preventive of disease .... '99, 270
  some common diseases of .... '98, 225
Memorial from Connecticut Agricultural College .... '25, 657
  Rothamsted Agricultural Station .... '25, 654
  Sheffield Scientific School .... '25, 656
Milk, act to prevent adulteration of ....'82, 92; '96, 73
  analyses of ....'82, 79; '83, 108; '86, 119; '97, 322
    methods of .... '86, 125
  condensed, powdered, malted .... '18, 399
  cryoscopy of .... '21, 251
  determination of fat in by Babcock method ....'91, 115; '94, 209
  food value of .... '19, 1
  observations on milk of a herd of cows .... '91, 96
  stringy .... '87, 102
  vitamines in .... '19, 21
[M]olasses, *act concerning adulteration of* .... '96, 74
  methods of examination of .... '88, 106
Mosquito, description and life history of ....'04, 260; '26, 268
  investigations .... '04, 253
  plague in Connecticut and how to control it .... '12, 259
  survey of Connecticut .... '04, 276
Mount Carmel farm, addition to .... '15, xiv
Nectarophora destructor .... '99, 240
Nematodes, *plant disease caused by* .... '15, 452
Nicotiana tabacum, correlation and inheritance in ....B. 171, '12
Niger seed, *anatomy with reference to miscroscopic examination*.. '03, 193
Nitric acid, apparatus for determining .... '89, 199
Nitrogen, apparatus for determining by Kjeldahl method .... '89, 191
  availability of, in bone as affected by slaked lime .... '99, 211
    superphosphates, tests of solubility of .... '15, 39
    various forms of organic matter vegetation tests of, '86, 80; '93, 226; '94, 74; '95, 99; '96, 178, 204; '97, 257; '98, 289; '99, 197, 204, 211, 217

Nitrogen—*Continued.*
by combustion with calcium hydroxide .... '83, 112
modified Gunning-Kjeldahl method .... '93, 171
use of iron tubes .... '77, 101
determination as nitrogen gas .... '79, 124
in agricultural products ....'78, 111; '79, 124
fertilizers containing nitrates ....'87, 126; '93, 173
methods to test the solubility of organic forms of by permanganate methods ....'09-'10, 430; '11, 9, 12
Nitrogenous matters, relative solubility by putrefaction .....'93, 226; '94, 109
in acid pepsin solution ....'85, 115; '93, 219; '94, 105; '00, 95
Nucleic acid of embryo of wheat, and its compounds ....'99, 305; '01, 365
Nurseries in 1926, inspection of .... '26, 181
Nursery stock, inspection of imported .... '26, 189
Nutrition, some essential facts regarding .... '17, 1
Odontocera dorsalis .... '94, 143
Onion brittle, experiments to prevent .... '06, 332
mildew, *Peronospora Schleideni* .... '89, 155
smut, *Urocystis Cepulae* .... '89, 129
transplanting as a prevention .... '95, 176
Onions, analysis of ash of .... '92, 155
mildew, study of .... '89, 155
smut, study of .... '89, 129
Oospora scabies, nov. sp. .... '91, 159
Orchard grass, study of seed of .... '92, 152
work at Mt. Carmel for ten years .... '16, 365
Orchards, spray treatment of ....B. 184, '14
Oriental peach moth .... '26, 234
Perilla, test of .... '20, 352
Peach bark beetle ....'94, 142; '95, 191
crop, nitrogen and mineral matters in .... '95, 157
curculio .... '94, 141
foliage and fungicides .... '00, 219
orchards, experiments in fertilization of.......'99, 283; '00, 352; '01, 283; '02, 443; '03, 428; '04, 444
general treatment of .... '25, 123
scab, probable winter condition of .... '96, 269
yellows and so-called yellows ....'07-'08, 872
Peaches, result of various summer sprays on ....'09-'10, 583; '11, 371
Pears, results of various summer sprays on .... '11, 396
Peas, a new insect enemy of .... '99, 240
Peanut, anatomy of, with reference to identification in food products '04, 191
Peat, effect of alkalies in developing fertilizing power of .... '80, 58
Phlegethontius Carolina .... '89, 178
Phosphates, field experiments with ....'87, 110; '88, 112; '89, 203
Phosphoric acid, a method for determination of....'78, 117; '80, 103; '89, 254
determination in fertilizers by citrate method .... '89, 254
of in presence of iron and alumina .... '90, 195
Phosphorus requirements of tobacco soils ....T. B. 7, '27
Phytomyza Aquilegiae .... '94, 145
Phytophthora, with reference to oospores, culture of ....'07-'08, 891
Pine in Connecticut, survey of white ....'21, 11, 323
infection experiments with *cronartium ribicola* .... '18, 428
wooly aphis on .... '98, 273
Plant breeding, relation of biological principles to ....B. 158, '07
Poppy seed, anatomy with reference to microscopic examination .. '03, 194
Potash as a potato fertilizer, field experiments with .... '95, 117

Potato blight, *Phytophthora* infestans, oospores of ....'09-'10, 753
breeding, some essential points in ....'07-'08, 429
scab ....'90, 81; '91, 153; '96, 246
experiments in prevention of ....'94, 118; '95, 166; '96, 246
transmission of variations in asexual reproduction ....'09-'10, 117
Potatoes, analyses of .... '87, 108
blight or downy mildew of ....'04, 363; '05, 304
coöperative spraying .... '18, 413
effect of potash as a fertilizer .... '95, 117
fertilizing experiments with .... '18, 421
spraying experiments .... '15, 470
in dry seasons ....'09-'10, 739
tests, coöperative ....'16, 355; '18, 411
Poultry keeping in the city as a war measure .... '17, 217
Primroses, flea beetle injuring .... '99, 243
Privet, effects of nitrogenous fertilizers on California .... '99, 217
Proteids, investigation of .... '04, 457
of Adzuki bean .... '96, 387
barley .... '94, 165
corn (maize) kernel ....'91, 136; '96, 391
cotton seed .... '93, 211
cowpea .... '96, 380
crystallized vegetable .... '92, 138
egg white ....'98, 317; '99, 348
yolk .... '99, 339
Proteids of flaxseed .... '92, 132
horse bean .... '97, 349
kidney bean .... '93, 186
lentil .... '97, 337
lupin .... '96, 342
malt .... '95, 239
oat ....'90, 115; '91, 124
pea and vetch ....'95, 262, 275, 286
potato .... '95, 255
rye .... '94, 147
soy bean .... '97, 374
sun flower .... '96, 374
various nuts ....'95, 292; '97, 324, 361
wheat ....'92, 143; '93, 175
embryo .... '99, 311
Protein bodies, state of combination of nitrogen in .... '02, 448
sulphur in .... '00, 443
molecule, basic character of .... '00, 399
carbohydrate group in .... '02, 459
Proteins of milk .... '19, 7
crystallized vegetable .... '92, 138
precipitation limits with ammonium sulphate .... '02, 457
specific rotation of .... '02, 458
tryptophane reaction of .... '02, 462
Proteose ....'97, 372; '99, 327
Publications of biochemical department ....'18, xv; '19, xiii; '20, xi; '21, 5
entomological department ....'19, xiv; '20, xii; '21, 9; '26, 162
Publications of members of the Station staff ....'23, 145; '24, 202
plant breeding department ....'18, xv; '19, xiii; '20, xii; '21, 14; '22, 179
Pyralis costalis .... '00, 315
Quince, use of fungicides to prevent spot of .... '91, 150
Radishes grown under glass, experiments with ....'96, 222; '97, 304
Rainfall, evaporation and percolation of .... '80, 91

Raspberry root gall fly ..... '95, 206
Redding, forest survey of ..... '16, 383
Roses under glass, note on fertilizers for ..... '98, 268
Rust, infection of leaves in Petri dishes ..... '23, 475
Rusts on *Ribes*, inspection of herbaria for ..... '18, 423
Salt marsh plants, composition of ash of ..... '89, 241
San Jose scale ..... '95, 192, 194; '97, 314; '99, 249
Satin moth ..... '26, 264
Schizoneura Rileyi ..... '99, 241
Screenings of wheat, composition of and anatomy of constituents.. '02, 339
Seeds, examination of....'79, 121; '80, 96; '82, 93; '83, 96; '84, 119; '97, 383; '98, 310; '99, 298; '01, 286; '02, 424; '03, 432; '04, 438; '06, 395; '09-'10, 805; '15, 497
  found in feeds ..... B. 161, '09
  germination, standards for ..... '26, 108
  sold in packets 1925-1926, quality of ..... '26, 99
Serica trociformis ..... '98, 269
Seasame, anatomy with reference to microscopic exam. of ..... '03, 190
Shade trees, protection of ..... '00, 330
Shepard, James, gift to herbarium ..... '07-'08, xvii
Snow method of curing tobacco ..... '91, 187
Soda-lime for nitrogen determination, preparation of ..... '77, 100
Soil acidity, new method of determining ..... T. B. 8, '27
  relation to root rot ..... T. B. 8, '27
Soils, adjusting reaction with lime ..... '26, 81
  analyses, tests and discussion of ..... '80, 67; '82, 65; '16, 59
Soils, analysis, methods of mechanical ..... '86, 141; '87, 144; '88, 154
  steam sterilizer for ..... '97, 310
  studies on relation of water to ..... '77, 76; '78, 83
Sorghums, anatomy of the fruit of certain cultivated ..... '02, 326
Soy beans, purification of varieties of ..... '16, 348
  tests of ..... B. 185, '15; B. 190, '17
    in 1915 ..... B. 191, '16
Spray calendar and bulletins..B. 142, '03; B. 143, '03; B. 159, '08; B. 183, '15; '17, 53; '20, 69; '22, 181; '25, 91
  mixtures, bibliography of chemical examinations of ..... '24, 212
  treatment of orchards ..... B. 184, '14
Spraying calendars ..... '93, 108
  vs. dusting of fruit trees ..... '26, 228
Sprays on fruit trees, summer ..... '09-'10, 583
Spruce gall aphid and its control ..... '26, 223
Starch, notes on determination of ..... '87, 128
State forests ..... '02, 469
Station, act concerning appointment of state entomologist ..... '01, vii
  food products ..... '95, xv
  printing of reports of ..... '80, 118
  reforestation of barren lands ..... '01, 362
  sale of fertilizers ..... '80, 116
  incorporating ..... '77, 7
  providing site for ..... '82, 108
  Adams act for support of ..... '06, xii
  address on relation of federal government to ..... '25, 629
  appropriation for equipment ..... '95, xv
  buildings, report of building committee ..... '84, 121
  fiftieth anniversary of founding of ..... '25, 191, 615
  fire-proof addition to laboratory of ..... '09-'10, xii
  forage garden of ..... '87, 163
  forcing house, description of ..... '96, 229
  grounds, report of changes in ..... '97, xii

Station—*Continued.*
herbarium, gift to ....'07-'08, xvii
historical sketch of .... '25, 621
library, gift to ....'07-'08, xvii
purchase and equipment of site for .... '82, 7
of Clark field .... '05, 5
recipient of one-half of Adams fund .... '06, xiii
semi-centennial of .... '25, 615
various laws regarding its duties .... '12, xiv
Sterilizer for soils .... '97, 310
Summer sprays on fruit trees .... '11, 347
Thielavia basicola, perithecia of in cultures and their stimulation by
extracts of other fungi .... '24, 539
Timothy as a cover crop for tobacco land .... '20, 354
Tobacco, analysis of air-dry leaf .... '96, 325
parts of, ashes ....'11, 95; '21, 101
dust, '85, 100; '88, 79; '92, 113; '96, 162; '04, 92; '09-'10, 114, 448; '17, 421; '18, 166; '20, 61; '25, 80
leaf ....'84, 96; '96, 325
stalks ....'84, 104; '87, 83; '92, 31; '07-'08, 117; '16, 55; '19, 91
ashes of ....'02, 85; '03, 93; '06, 102; '07-'08, 117
stems ....'78, 36; '85, 100; '86, 68; '88, 79; '89, 114; '96, 162; '97, 148; '00, 92; '01, 81; '02, 79, 86; '03, 91; '04, 91; '06, 104; '09-'10, 114; '11, 96; '13, 178; '15, 69; '17, 421; '18, 166; '20, 61; '22, 142; '25, 80
area of leaf surface of .... '99, 297
black rot and soil reaction .... '25, 59T
breeding, experiments in ....'04, 449; '05, 331
in Connecticut ....B. 176, '13
calico and mottle top .... '98, 242
effect of lime and shading on .... '99, 252
changes in, during fermentation .... '92, 28
composition of leaf, effect of fertilizers on .... '96, 322
Connecticut round tip .... '20, 285
correlation and inheritance in ....B. 171, '12
cover crop for .... '25, 55T
curing and fermenting, experiment in ....'97, 223; '98, 297; '99, 286
shade grown .... '22, 41T
with artificial heat ....'91, 187; '92, 36; '93, 82
distinctive disease of in South Carolina .... '96, 273
• diseases in 1926 ....T. B. 8, '27
effect of chlorides on burning quality of .... '26, 92
shading and liming in controlling calico .... '99, 252
fermenting in bulk .... '98, 302
fertilizer experiments with ....T. B. 8, '27
formulas for .... '92, 24
fields, vetch as a cover crop for ....B. 149, '05
grain of .... '99, 262
growing Sumatra type under shade ....'00, 322; '01, 295; '02, 446
with different fertilizers ..'92, 1; '93, 112; '94, 254; '95, 128, 146; '96, 285, 302; '97, 223, 230, 243; '24, 3T; '25, 6T
results of five years experiments ....'96, 310; '97, 243
Heber process of fermenting ....T. B. 8, '27
insects in 1926 ....T. B. 8, '27
leaf surface, area of .... '99, 297
leaves, shrinkage in size during curing and fermentation ...... '13, 390
lime for, supply of .... '84, 87
nature of the grain of .... '99, 262
pole burn of ....'91, 168; '93, 84
root rot of *Thielavia basicola* .... '91, 166

Tobacco—*Continued.*
seed beds, management of .... B. 166, '10
shade cloth, preservative treatment of .... T. B. 8, '27
soils, phosphorus requirements of .... T. B. 7, '27
Station, report for 1896 .... T. B. 8, '27
stems .... '26, 90
Stewart Cuban variety .... '13, 385
soil tests and analyses of .... '16, 59
strains, tests of .... T. B. 8, '27
Sumatra, selection of strains of .... '03, 440
tests of strains of .... '25, 37T
wild fire .... '21, 365; '22, 2T; '23, 2T
literature of .... '21, 422
worms .... '25, 90T
Tobacco, Experiment Station, establishment of .... '21, v
reports of .... '22, 1T; '23, 1T; '25, 3T
Tomato Plusia .... '95, 205
Tomatoes, effect of cross and self-fertilization of .... '16, 305
in forcing house, use of fertilizers for..'95, 75; '96, 205; '97, 278; '99, 219
Tree protection examining board, report of ....'19, v; '20, 339; '24, 141
surgery, paper on .... '24, 153
Tryptophane reaction of proteids .... '02, 462
Valuation of fertilizers, explanation of .... '14, 45
Vegetation experiments to determine availability of organic nitrogen .... '86, 88; '94, 74; '95, 99
house, building of .... '94, xv, 75
for pot experiments .... '00, 306
Vetch, Russian, a cover crop for tobacco .... B. 149, '05
Vicilin .... '97, 369
Violet roots, fungus on *Thielavia basicola* .... '91, 166
Violets, mineral matter and nitrogen in .... '97, 312
Vitellin .... '95, 288
Weed seeds in feeds .... B. 161, '09
Wheat middlings, beetle infecting .... '99, 243
seed, nucleic acid of embryo of .... '99, 305
tests of varieties of winter .... '16, 428
Wood lot, improvement of .... B. 154, '06
using industries of Connecticut .... B. 174, '13

INDEX TO ANALYSES OF MISCELLANEOUS MATERIALS WITH REFERENCE TO MANURIAL VALUE

Alphano Humus .... '18, 167
Apple pomace, analyses of .... '80, 67; '14, 108
Ashes, anthracite .... '95, 68
black birch brush .... '04, 96; '15, 79
brick kiln .... '84, 71; '88, 79; '04, 95; '06, 102; '15, 79; '09-'10, 110
corn cob .... '98, 85
cotton hull ... '81, 56; '83, 68; '84, 70; '85, 99; '86, 66; '87, 80; '88, 78; '89, 108; '90, 68; '91, 82; '92, 107; '93, 57; '94, 62; '95, 61; '96, 157; '97, 140; '98, 84; '99, 82; '00, 86
complete analyses of .... '97, 144; '01, 78; '02, 87; '03, 93; '04, 94; '05, 101; '06, 97; '07-'08, 109, 562; '09-'10, 107, 445; '11, 92; '18, 131
feeding stuffs .... '86, 115
garbage .... '06, 103, 104
household wastes .... '17, 419
lime kiln .. '81, 54; '87, 82; '90, 69; '91, 87; '94, 64; '96, 161; '97, 146; '98, 88; '00, 90; '01, 82; '02, 90; '03, 95; '04, 95; '05, 103; '06, 101; '07-'08, 115, 568; '09-'10, 111; '11, 91; '13, 175; '15, 79; '18, 164; '19, 102; '20, 63
muck and peat .... '77, 31; '96, 162
rice hulls .... '07-'08, 117
wood, household .... '83, 69; '84, 70; '07-'08, 566; '91, 87
leached .... '78, 34; '79, 44; '80, 40; '81, 56; '83, 70; '86, 67; '97, 146; '02, 83
unleached .... '79, 45; '80, 39; '87, 82; '88, 79; '89, 109; '90, 68; '91, 81
complete analyses .. '92, 108; '93, 61; '94, 63; '95, 62; '96, 159; '97, 146; '98, 88; '99, 84; '00, 90; '01, 82; '02, 82, 84; '03, 96; '04, 92; '05, 102; '06, 100; '07-'08, 112, 564; '09-'10, 110, 445; '11, 94; '12, 90; '13, 176; '14, 111; '15, 79; '16, 51; '17, 418; '18, 165; '19, 102; '20, 65; '21, 106; '22, 140; '23, 83; '24, 89; '25, 71
Basic slag .... '12, 26
Bat guano .... '98, 89; '13, 178; '18, 163
Butter .... '91, 122; '92, 130; '97, 323
Buttermilk, curd from .... '93, 64
Cocoa shells .... '13, 178
Coffee grounds .... '17, 421
Eel grass .... '81, 65
Feeding stuffs, ash analyses of .... '86, 115
Fertilizer, complete analyses of .... '84, 89
Garbage tankage .... '01, 85; '02, 91; '03, 98; '18, 168
Glue refuse .... '22, 142
Gunpowder waste .... '16, 56
Hoof meal .... '90, 26
Hops, *spent* .... '06, 104; '17, 421
Horn shavings and dust .... '80, 36; '85, 97; '92, 112; '93, 21; '26, 89
agricultural value of .... '86, 80; '89, 65
Jadoo fiber .... '98, 91
Kelp .... '81, 65; '17, 422; '19, 104
Leather chips .... '80, 65
Leaves, ashes of .... '83, 79
at *different stages of growth, composition of* .... '83, 77
Lime, acetylene residue .... '00, 94; '13, 175; '15, 77; '16, 53
oyster shell .... '79, 39; '92, 111; '98, 88; '03, 95; '04, 97; '13, 172; '16, 53
quick and slaked .. '82, 50; '83, 66; '97, 148; '00, 90; '04, 97; '05, 104; '06, 101; '07-'08, 115, 568; '09-'10, 444, 453; '11, 88; '12, 89, 90; '13, 174; '14, 110; '16, 53; '18, 164; '20, 63; '24, 96; '25, 76; '26, 86

Limestone ...'81, 58; '82, 52; '83, 63; '90, 69; '02, 89; '07-'08, 114; '11, 88; '12, 88; '13, 170; '14, 110; '15, 77; '16, 52; '17, 419; '20, 63; '23, 86; '24, 96; '25, 77; '26, 86
Manure, bat ....'13, 178; '18, 163
cow ....'89, 120; '90, 71
elephant .... '84, 72
hen ....'79, 34; '82, 46; '84, 71; '86, 69; '88, 80; '91, 88; '12, 91
hog .... '90, 71
horse ....'00, 94; '09-'10, 446
pigeon ....'90, 73; '06, 105
rabbit .... '18, 163
sheep, '94, 65; '00, 94; '02, 92; '03, 95; '06, 104; '07-08, 114, 116; '09-'10, 113, 447; '11, 95; '12, 92; '13, 177; '14, 104; '15, 67; '16, 50; '17, 416, 422; '18, 163; '19, 100; '20, 62; '21, 104; '22, 141; '23, 86; '24, 91; '25, 73
stable ....'80, 43; '89, 117
Marl, shell ....'79, 43; '82, 52; '12, 90; '13, 172
New Jersey sand ....'79, 46; '22, 144; '23, 86; '24, 100; '25, 80
Muck, swamp, '77, 32; '78, 38; '79, 50; '81, 61; '82, 63; '83, 71; '84, 74; '85, 101; '86, 71; '87, 84; '89, 115; '91, 89; '92, 113; '93, 62; '95, 67; '96, 162; '00, 93; '01, 87; '07-'08, 569; '09-'10, 115, 450; '11, 97; '13, 180; '14, 106; '15, 69; '16, 54; '17, 420; '18, 166; '19, 103; '21, 108; '22, 142; '23, 87
Mud, marine, '77, 30, 33; '79, 47; '82, 54; '84, 73; '95, 67; '07-'08, 119; '09-'10, 450; '16, 57; '17, 422; '18, 167
Mussel bed ....'81, 60; '19, 104
Mussels .... '89, 116
Night soil .... '81, 48
Onions, ash analysis of .... '92, 155
Oyster shells ....'13, 172; '16, 53
Peach wood, analysis of .... '84, 93
Peaches, analyses of pulp and stones .... '95, 157
Peas and beans, amounts of N.P_2O_5 and K_2O in .... '96, 334
Peat moss .... '93, 62
Plaster, land ..'80, 42; '83, 62; '88, 81; '89, 116; '90, 70; '02, 92; '04, 97; '09-'10, 114
Rape meal .... '16, 56
Red rock .... '78, 51
Rock weed ....'81, 65; '90, 71
Salt .... '82, 73
Saltpeter waste ....'07-'08, 118
Seaweed ....'81, 64; '90, 72
Sewage sludge ....'09-'10, 448; '21, 108; '23, 87; '24, 92
Shoddy ....'11, 97; '13, 179
Soils ....'77, 33; '80, 70; '82, 65; '16, 59; '17, 422
Soot ....'01, 84; '06, 104; '09-'10, 113; '16, 56; '17, 422
Sponge .... '90, 72
Star fish ....'86, 69; '17, 421
Strawberry, ashes of .... '79, 67
Street sweepings .... '98, 90
Tartar pomace ....'07-'08, 118
Thomas slag .... '86, 32
Tobacco wastes, see *Tobacco, analysis of parts of in general index*
Tortoise shell saw dust .... '81, 46
Vegetable ivory .... '80, 44
Violets, complete ash analysis of .... '97, 312
Wool waste ....'90, 70; '92, 112; '01, 84

MEMBERS OF THE BOARD OF CONTROL AND EMPLOYEES OF THE STATION

1877-1926

Adams, W. L., '17, xiii; '18, xiv.
Alsop, J. W., '11, iii.
Anderson, P. J., '25, iii, 204.
Andrews, I. A., '04, ii, ix; '05, iii, 3.
Andrews, R. E., '20, v.
Archer, Geo., '82, ii.
Armsby, H. P., '77, 2; '81, 7.
Ashworth, J. T., '20, v.
Atwater, W. O., '79, 2; '07-'08, ix; '25, 622 (portrait) (obituary notice).
Avery, Miss E. L., '09-'10, iii; '20, v.

Bacon, Miss Mabel, '23, iii, 144.
Bailey, E. M., '02, ii, xii.
Barber, Miss K. G., '04, ii, ix; '07-'08, xi.
Benedict, F. G., '06, iii.
Berger, Miss J. V., '21, iii, '27, iii.
Bigelow, Miss F. M., '88, ii; '93, iii.
Bogardus, E. H., '83, 2.
Botsford, Miss C. A., '07-'08, iii.
Botsford, R. C., '23, iii, 144.
Bradley, Miss Mary E. (Mrs. R. A. Hunter), '23, iii, 144.
Brautlecht, C. A., '07-'08, xi; '09-'10, xi.
Brautlecht, Miss L. M., '01, xiii.
Brewer, W. H., '77, 2; '02, xii; '09-'10, iii; '11, ix (obituary).
Britton, W. E., '94, xvi; '18, vii.

Caffrey, D. J., '13, ix, 184.
Cannon, H. C., '26, iii.
Campbell, G. F., '94, iii.
Chamberlain, K. F., '19, iii; '20, v.
Champlain, A. B., '09, iii; '11, xi.
Chapman, G. H., '21, v; '23, 144.
Churchill, V. L., '97, iii.
Clinton, G. P., '02, ii, xii; '09-'10, xi.
Cole, Miss V. E., '98, iii; '22, v.
Collins, B. W., '00, ii; '07-'08, iii; '09-'10, xi.
Conn, H. W., '07-'08, iii; '17, v (obituary notice).
Copeland, R. N., '21, vi.
Curtiss, R. S., '88, ii; '90, ii; '93, xvi.

Davis, G. L., '13, ix; '16, xix.
Davis, I. W., '13, ix; '18, vii; '19, xii.
DeBussey, Miss Martha, '18, iii; '19, 116.
D'Esopo, M., '17, xiii; '20, v.
Dudley, H. L., '84, 2; '92, iii.

East, E. M., '05, iii, 3; '09-'10, xi.
Edmond, H. D., '18, xiv; '21, vi.

Farrington, E. H., '83, 2; '88, ii.
Ferry, Miss E. L., '09, iii; '19, v (obituary notice).
Filley, W. O., '09-'10, xi; '11, xi; '12, ix; '18, vii.
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Fisher, H. J., '21, vi.
Foote, Miss G. A., '15, iii; '18, xiv.
Francis, Miss Luva, '09-'10, iii.
Friend, R. B., '24, 201.

Garman, Philip, '19, iii.
Gerchewski, H., '89, ii.
Gold, T. S., '77, 2; '06, xi (obituary notice).
Graff, P., '07-'08, xi; '09-'10, xii.
Graham, G. E., '14, vii; '25, 204.
Green, Miss C. S., '93, iii; '97, iii.

Hall, W. H., '18, iii; '22, v.
Harris, I. F., '01, ii, xiii; '06, iii.
Hawes, A. F., '04, ix; '09-'10, xi.
Hayes, H. K., '09-'10, xi; '15, vii.
Hicock, H. W., '19, xii.
Hopson, G. A., '09-'10, xi.
Hoyt, E., '77, 2; '07-'08, ix (obituary notice).
Huber, H. F., '14, vii; '17, xii.
Hubbell, C., '09-'10, iii; '21, vi.
Hunt, W. R., '24, 201.
Hutchinson, C. A., '80, 2; '83, 2.
Hyde, E. H., '77, 2; '96, iii.

Jacobson, H. G. M., '26, iii.
Jagger, Miss M. H., '07-'08, xi; '14, vii.
Jarvis, C. M., '06, xi; '09, iii.
Jenkins, E. H., '77, 2; '92, iii; '18, vii; '23, v, 143; '25, 626, 650 (portraits).
Johnson, S. W., '77, 2; '00, xii; '01, xii; '09-'10, ix (obituary notice); '25, 617, 624 (portraits).
Johnston, W. R., '93, iii; '94, iii.
Jones, D. F., '15, vii.
Judd, Orange, '77, 2; '79, 2.

Kelsey, Mrs. L. D., '18, iii.
Kiley, Henry, 1895.
Kirk, H. B., '12, ix; '13, ix.
Korn, Julius, '93, iii; '97, iii.
Kreider, J. L., '05, iii; '06, xii.

Lange, H., '89, ii; '18, xiv.
Langley, C., '99, ii; '01, xiii.
Lee, W. H., '11, iii; '18, iii.
Lincoln, F. F., '24, 194.
Lowry, Q. S., '13, ix; '18, iii, xiv.

MacKenzie, K. G., '07-'08, xi.
Mangelsdorf, P. C., '21, vi; '27, 105.
Mathis, W. T., '24, 201.
McCormick, Miss F. A., '17, xiii.
McDonnell, A. D., '26, iii.
Merchant, Miss P. A., '20, iii.
Mendel, L. B., '18, viii.
Merwin, R. T., '21, iii.
Mitchell, W. L., '96, iii; '99, xiii.
Morison, C. B., '07-'08, xi; '18, vii; '19, xii.
Moss, Miss A. H., '18, iii; '21, iii.
Moss, A. E., '12, ix; '14, vii; '25, 204.

Morgan, M. F., '23, *iii*, 144.
Mulford, W., '01, ii; '04, ix.
Murray, H. R., '26, iii.

Nelson, N. T., '24, *201*.
Nolan, O. L., '20, iii, v.

Ogden, A. W., '90, ii; '04, ix.
Olcott, J. B., '87, 100; '09-'10, xii.
Osborne, T. B., '86, ii; '18, vii.

Pelton, W. C., '17, xii; '18, vii; '20, v.
Pokrob, W., '98, i; '04, ii.

Rice, C. J., '82, 2; '02, xii.
Rice, W. N., '89, *ii*; '91, *ii*.
Riley, J. E., '26, iii.
Rodman, C. W., '07-'08, xi; '09-'10, xi.
Roe, R. O., '09-'10, iii; '12, ix.
Rogers, E., '18, iii.
Rorer, J. B., '01, xiii.

Scarseth, G. D., '25, iii, 204.
Schneider, E. C., '22, v.
Schneider, E. A., '86, 9.
Sealy, S. T., '20, v; '23, 144.
Shanley, E. J., '05, iii, 3; '07-'08, xi.
Sheldon, Frank, '19, iii.
Shepard, C. E., '09-'10, xi.
Silverman, M., '01, xiii; '04, ix.
Singleton, W. R., '27, 105.
Slagg, C. M., '23, *iii*, 144; '24, *201*.
Slate, W. L., '22, v; '22, iii; '23, 143.
Smith, H. M., '93, iii.
Smith, Worthington, '92, iii.
Spring, S. N., '09-'10, xi; '12, ix.
Stadtmueller, F. H., '07-'08, xi; '18, v (obituary notice).
Stevens, H. R., '07-'08, xi.
Stoddard, E. M., '09-'10, *xii*.
Storrs, Mrs. A. M., '22, iii; '23, 144.
Street, J. P., '07-'08, xi; '18, vii; '19, xii.
Sturgis, W. C., '01, xiii; '02, xii.

Thaxter, R., '88, ii; '91, ii.
Treat, C. R., '19, iii.

Valentine, Miss F. M., '12, iii; '15, vii.
Veitch, W., '02, ii, xii; 25, 204.
Vickery, H. B., '26, iii.
Voorhees, C. G., '91, ii; '92, iii.

Washburn, *J. H.*, '86, 9.
Webb, J. J., '77, 2; '83, iii.
Webb, J. H., '93, iii; '24, v (obituary notice).
Wells, H. L., '78, 2; '80, 2.
Wells, S. M., '96, iii; '99, ii.
Whitney, Milton, '83, *ii*.
Whittlesey, Miss E. B., '07-'08, iii; '16, xix.
Williams, M. C., '01, xiii.
Winton, A. L., '84, 2; '07-'08, xi.

Zappe, M. P., '14, iii.

Employees on the Grant of the Carnegie Institution of Washington, D. C.

Name	Appointed	Resigned
C. A. Brautlecht	July 1, 1906	March 31, 1908
Helen C. Cannon	October 25, 1920	December 31, 1925
S. H. Clapp	March 15, 1905	August 31, 1907
A. C. Gilbert	June 7, 1905	March 31, 1906
Ralph D. Gilbert	October 1, 1904	March 31, 1906
Herbert H. Guest	June 13, 1910	July 29, 1911
Isaac F. Harris[1]	April 10, 1906	December 15, 1906
Frederick W. Heyl	June 1, 1907	June 30, 1908
Albert G. Hogan	July 1, 1913	September 16, 1913
Leigh I. Holdredge	October 19, 1909	July 31, 1912
D. Breese Jones	May 11, 1908	October 30, 1909
C. S. Leavenworth	January 5, 1908	
Leonard M. Liddle	July 1, 1909	August 31, 1910
E. V. McCollum	May 1, 1906	July 31, 1906
Clyde R. Newell	June 23, 1911	August 31, 1911
Laurence S. Nolan	April 10, 1910	
O. L. Nolan	May 13, 1907	March 31, 1920
H. B. Vickery	June 1, 1922	
Alfred J. Wakeman	April 1, 1912	

[1] Mr. Harris was on the station payroll before being on the Carnegie staff.

LIST OF STATION BULLETINS

Analysis of "Composition for Grass," No. 1.
Analysis of "Composition for Vegetables," No. 2.
Analysis of Soluble Pacific Guano, No. 3.
Fertilizer Analyses, Nos. 4 to 8.
Analyses of Leached Ashes and Egg Food, No. 9.
Fertilizer Analyses, Nos. 10 to 22.
Analyses of Hay, No. 23.
Fertilizer Analyses, Nos. 24 to 33.
Analyses of Hay, No. 34.
Analyses of Maize Kernel, No. 35.
Shell Marl, Marine Mud and Oyster Shell Lime, No. 36.
Fresh Water Sediments, No. 37.
Fertilizer Analyses, Nos. 38 to 43.
Pollard Fertilizers: Caution, No. 44.
Fertilizer Analyses, Nos. 45 to 47.
Forester's Fertilizers, No. 48.
Analyses of Swamp Muck, No. 49.
Fertilizer Analyses, Nos. 50 and 51.
Cost of Active Ingredients of Fertilizers During 1880 and Trade-Value Adopted by the Station for 1881, No. 52.
The Bird Guano and Fertilizer, No. 53.
"Ashes, from Factories in Canada," No. 54.
Night Soil, No. 55.
Bone Saw Dust, No. 1 Peruvian Guano and Tortoise Shell Saw Dust, No. 56.
Fertilizer Analyses, No. 57.
Superphosphates, Guanos, No. 58.
Fertilizer Analyses, No. 59.
An Act Concerning Commercial Fertilizers, No. 60.
Special Manures and Superphosphates, No. 61.
Fertilizer Analyses, Nos. 62 to 67.
Trade Values for 1882, No. 68.
Fertilizer Analyses, Nos. 69-71.
Fertilizer Law and Analyses, No. 72.
Fertilizer Analyses, No. 73.
Explanation of Analyses, 74.
Fertilizer Analyses, Nos. 75 to 92.
Grasses, No. 93.
Fertilizer Analyses, April, 1888, No. 94.
Fertilizer Analyses, June, 1888, No. 95.
Analyses and Valuation of Feeding Stuffs, No. 96.
Fungous Diseases of Plants (and Fertilizer Analyses), No. 97.
Home Mixed Fertilizers, No. 98.
Fertilizer Analyses, June, 1889, No. 99.
Fertilizer Analyses, September, 1889, No. 100.
Fertilizer Analyses, January, 1890, No 101.
Fungicides, No. 102.
Fertilizers, No. 103.
Fertilizers, No. 104.

NOTE. From 1877 to 1916, inclusive, the station's annual reports consisted of the results of investigations reported by the staff. Beginning with 1905, the reports are divided into parts, for example, "Part II, Fifteenth Report of the State Entomologist," Report for 1915. At this time, the bulletins were of a more popular nature or took the form of monographs. Commencing with the Forty-First Report, 1917, this distinction was dropped and all publication was in the bulletin series, those issued each year being brought together to constitute the annual report.

A few of the earlier reports and bulletins are now available for distribution to libraries and a list may be obtained from the station.

Potato Scab, Proteids of the Oat Kernel, Milk Testing, No. 105.
Babcock Method of Determining Fat in Milk and Cream: Analyses of Butter; Fertilizers, No. 106.
Connecticut Species of *Gymnosporangium*, No. 107.
Examination of the Seed of Orchard Grass: Ash Analysis of White Globe Onions: Determination of Fat in Cream by the Babcock Method, No. 108.
Fertilizers, No. 109.
Fertilizers, No. 110.
Common Fungous Diseases and Their Treatment, No. 111.
Gunning-Kjeldahl Method and a Modification Applicable in the Presence of Nitrates, No. 112.
Fertilizers, No. 113.
Fertilizers, No. 114.
Common Fungous Diseases and Their Treatment, No. 115.
Fertilizers, No. 116.
Babcock Method of Determining Fat in Milk and Milk Products, No. 117.
Literature of Fungous Diseases. A Provisional Bibliography, No. 118.
The Babcock Test as a Basis for Payment in Cream-Gathering Creameries, No. 119.
Analyses of Fertilizers. Trade Values of Fertilizer Ingredients for 1895. Poultry, No. 120.
Elm Leaf Beetle and San José Scale, No. 121.
Cost of Nitrogen, Phosphoric Acid and Potash in Connecticut, No. 122.
Examination of Food Products Sold in Connecticut, No. 123.
The Cost of Plant Food in Connecticut, No. 124.
Preparation and Application of Fungicides, No. 125.
Insecticides: Their Preparation and Use, No. 126.
Cost of Plant Food in Connecticut, Spring Months of 1898, No. 127.
Commercial Feeding Stuffs in the Connecticut Market, No. 128.
Inspection and Care of Nursery Stock, No. 129.
Commercial Feeding Stuffs in the Connecticut Market, No. 130.
The Protection of Shade Trees in Towns and Cities, No. 131.
Condimental and Medicinal Cattle and Poultry Foods, No. 132.
Commercial Feeding Stuffs in the Connecticut Market, No. 133.
The New Law Concerning Insect Pests, 134.
The San José Scale-Insect: Its Appearance and Spread in Connecticut, No. 135.
Preliminary Experiments in Spraying to Kill the San José Scale-Insect, Season of 1901, No. 136.
The Growing of Tobacco Under Shade in Connecticut, No. 137.
Commercial Feeding Stuffs in the Connecticut Market, No. 138.
The Apple Tree Tent-Caterpillar, No. 139.
The White-Fly or Plant-House Aleyrodes, No. 140.
Commercial Feeding Stuffs in the Connecticut Market, No. 141.
Spray Calendar, No. 142.
Two Common Scale-Insects of the Orchard, No. 143.
Fighting the San José Scale-Insect in 1903, No. 144.
Commercial Feeding Stuffs in the Connecticut Market, No. 145.
San José Scale-Insect Experiments in 1904, No. 146.
Commercial Feeding Stuffs in the Connecticut Market, No. 147.
The Preparation of Tobacco Seed, No. 148.
A New and Valuable Cover-Crop for Tobacco Fields, No. 149.
The Selection of Tobacco Seed Plants, No. 150.
The Chief Injurious Scale-Insects of Connecticut, No. 151.
The Improvement of Corn in Connecticut, No. 152.
The Gipsy Moth and The Brown-Tail Moth, No. 153.
Chestnut in Connecticut and the Improvement of the Woodlot, No. 154.
The Elm Leaf Beetle, No. 155.
Cotton Seed Meal as a Fertilizer, No. 156.

Lead Arsenate and Paris Green, No. 157.
The Relation of Certain Biological Principles to Plant Breeding, No. 158.
Spray Calendar, No. 159.
Clover Seed in the Connecticut Market, No. 160.
Feeds, Seeds and Weeds, No. 161.
Forest Survey of Litchfield and New Haven Counties, Connecticut, No. 162.
Agricultural Lime; Its Sources, Composition and Prices. With Notes on Its Action in the Soil, No. 163.
Garden and Field Seeds Sold in Connecticut in 1908-1909, No. 164.
San José Scale and Methods of Controlling It, No. 165.
The Management of Tobacco Seed Beds, No. 166.
Inheritance in Maize, No. 167.
Improvement in Corn, No. 168.
The Leopard Moth, No. 169.
The Trade in Cotton Seed Meal, No. 170.
Correlation and Inheritance in Nicotiana Tabacum, No. 171.
The Net Weight or Volume of Food Products Which are Sold in Packets, No. 172.
The Mosquito Plague of the Connecticut Coast Region and How to Control It, No. 173.
Wood-Using Industries of Connecticut, No. 174.
The Cost of Agricultural Lime in Connecticut, No. 175.
Tobacco Breeding in Connecticut, No. 176.
The Apple-Tree Tent-Caterpillar, No. 177.
The Chestnut Bark Disease, No. 178.
Soy Beans, No. 179.
Studies on the Tobacco Crop of Connecticut, No. 180.
Some Common Lady Beetles of Connecticut, No. 181.
The Brown-Tail Moth, No. 182.
Spray Calendar, No. 183.
Spray Treatment, etc., for Orchards, No. 184.
Tests of Soy Beans, 1914, No. 185.
The Gipsy Moth, No. 186.
Index to Reports on Food Products and Drugs, No. 187.
Further Experiments on Inheritance in Maize, No. 188.
A Mosquito Survey at the Mouth of the Connecticut River, No. 189.
Insects Attacking Cabbage and Allied Crops in Connecticut, No. 190.
Tests of Soy Beans, 1915, No. 191.
Observations on Alfalfa, No. 192.
Tests of Soy Beans, 1916, No. 193.
Manure from the Sea, No. 194.
Insects Injuring Stored Food Products in Connecticut, No. 195.
Some Essential Facts Regarding Nutrition, No. 196.
The Cereal Breakfast Foods, No. 197.
Domestic Supplies of Potash, No. 198.
Spray Calendar, No. 199.
Report on Food and Drug Products, 1917, No. 200.
Food Oils and Fats, No. 201.
An Experience in Keeping Poultry in the City, No. 202.
Report of the State Entomologist, 1917, No. 203.
Report on Commercial Fertilizers, 1917, No. 204.
Beekeeping for Connecticut, No. 205.
Report on Commercial Feeding Stuffs, 1917, No. 206.
The Effects of Inbreeding and Crossbreeding Upon Development, No. 207.
Insects Attacking the Potato Crop in Connecticut, No. 208.
Report on Commercial Fertilizers, 1918, No. 209.
Report on Food and Drug Products, 1918, No. 210.
Report of the State Entomologist, 1918, No. 211.
Report on Commercial Feeding Stuffs, 1918, No. 212.
Condensed Milk, Malted Milk, Milk Powder, No. 213.

Report of the Botanist for 1917 and 1918, No. 214.
The Food Value of Milk, No. 215.
Insects Attacking Squash, Cucumber, and Allied Plants in Connecticut, No. 216.
Report on Commercial Fertilizers, 1919, No. 217.
Report of the State Entomologist, 1919, No. 218.
Report on Food and Drug Products, 1919, Part I, No. 219.
Report on Food and Drug Products, 1919, Part II, No. 220.
Report on Commercial Feeding Stuffs, 1919, No. 221.
New or Unusual Plant Injuries and Diseases Found in Connecticut, 1916-1919, No. 222.
Report on Commercial Fertilizers, 1920, No. 223.
Spray Calendar, No. 224.
A Study of the Bulb Mite, No. 225.
Report of the State Entomologist, 1920, No. 226.
Report on Food and Drug Products, 1920, No. 227.
Connecticut Round Tip Tobacco, No. 228.
Report on Commercial Feeding Stuffs, 1920, No. 229.
The Grass-Feeding Frog-Hopper or Spittle-Bug, No. 230.
Report of the Tree Protection Examining Board, No. 231.
Report of the Director for the Year Ending October 31, 1921, No. 232.
Report on Commercial Fertilizers, 1921, No. 233.
Report of the State Entomologist, 1921, No. 234.
Experiments in Dusting versus Spraying on Apples and Peaches in Connecticut in 1921, No. 235.
Report on Food and Drug Products, 1921, No. 236.
Control of White Pine Blister Rust in Connecticut, No. 237.
Report on Commercial Feeding Stuffs, 1921, No. 238.
Wildfire of Tobacco in Connecticut, No. 239.
Report on Food and Drug Products, 1922, Part I, No. 240.
Report on Commercial Fertilizers, 1922, No. 241.
Report on Commercial Insecticides and Fungicides, 1922, No. 242.
Report of the Director for the Year Ending October 31, 1922, No. 243.
Spray Calendar, No. 244.
Results of Dusting versus Spraying in Connecticut Apple and Peach Orchards, 1922, No. 245.
The Apple and Thorn Skeletonizer, No. 246.
Report of the State Entomologist, 1922, No. 247.
Report on Food and Drug Products, 1922, No. 248.
Report on Commercial Feeding Stuffs, 1922, No. 249.
Report on Commercial Fertilizers, 1923, No. 250.
The Raspberry Fruit Worm, No. 251.
The European Red Mite, No. 252.
Better Forests for Connecticut, No. 253.
Report of the Director for the Year Ending October 31, 1923, No. 254.
Report on Food and Drug Products, 1923, No. 255.
Report of the State Entomologist, 1923, No. 256.
Report on Commercial Feeding Stuffs, 1923, No. 257.
Report on Commercial Insectieides and Fungicides, No. 258.
Corn in Connecticut, No. 259.
Rust Infection of Leaves in Petri Dishes, No. 260.
Report on Commercial Fertilizers, 1924, No. 261.
The Rainbow Forest Plantations, No. 262.
Second Report of the Tree Protection Examining Board, No. 263.
Report of the Director for the Year Ending October 31, 1924, No. 264.
Report of the State Entomologist, 1924, No. 265.
The Improvement of Naturally Cross-Pollinated Plants by Selection in Self-Fertilized Lines. 1. The Production of Inbred Strains of Corn, No. 266.
Report on Food and Drug Products, 1924, No. 267.
Report on Commercial Feeding Stuffs, 1924, No. 268.

Perithecia of Thielavia Basicola Zopf in Culture and the Stimulation of Their Production by Extracts from other Fungi, No. 269.
Report on Commercial Fertilizers, 1925, No. 270.
Spray Bulletin, No. 271.
Report on Commercial Insecticides and Fungicides, 1925, 272.
Crossed Corn, No. 273.
Report of the Director for the Year Ending October 31, 1925, No. 274.
Report of the State Entomologist, 1925, No. 275.
Report on Food and Drug Products, 1925, No. 276.
Report on Commercial Feeding Stuffs, 1925, No. 277.
A Chemical Investigation of Some Standard Spray Mixtures, No. 278.
The Genetics and Morphology of Some Endosperm Characters in Maize, No. 279.
Semi-Centennial of The Connecticut Agricultural Experiment Station, No. 280.
General Index State Entomologist's Reports, 1901-1905, No. 281.
Report on Commercial Fertilizers, 1926, No. 282.
Quality of Vegetable Seeds Sold in Packets in Connecticut, 1926, No. 283.
Index Food and Drugs, 1915-1925, No. 284.
Report of the State Entomologist, 1926, No. 285.
Report on Food and Drug Products, 1926, Part I, No. 286.
Report on Food and Drug Products, 1926, Part II, No. 287.
Biology of Birch Leaf Skeletonizer, No. 288.
Report on Commercial Feeding Stuffs, 1926, No. 289.
Report on Commercial Fertilizers, 1927, No. 290.
Report of the Director for the Year Ending October 31, 1927, No. 291.
Some Insect Pests of Nursery Stock in Connecticut, No. 292.
Quality of Vegetable Seed Bought by Market Gardeners in Connecticut, No. 293.
Report of the State Entomologist, 1927, No. 294.
Report on Food and Drug Products, 1927, No. 295.

BULLETINS OF IMMEDIATE INFORMATION

Combating the San José Scale in 1905, No. 1.
Blight and Rot of Potatoes, No. 2.
Fumigation and Treatment of Nursery Stock, No. 3.
Root-Rot of Tobacco, No. 4.
The Gipsy Moth Situation and the New Law, No. 5.
The Uses of the Agricultural Experiment Station, No. 6.
"Universal Military Service," for Farmers, No. 7.
Diseases of Bees: Their Detection and Treatment, No. 8.
The Connecticut Fertilizer Law, No. 9.
The Treatment of Apple Trees Girdled by Mice, No. 10.
Why We Must Have Vegetables, No. 11.
Wild Fire of Tobacco, No. 12.
Spray Now to Kill European Red Mite, No. 13.
The Attention of Purchasers of Fertilizers, No. 14.
Warning to Tobacco Growers, No. 15.
Reparding Connecticut Sweet-Corn Seed, No. 16.
Control of Ant Invasions, No. 17.
The Gipsy Moth Quarantine, No. 18.
Winter Pruning of Fruit Trees, No. 19.
Dormant Sprays on Orchard Trees, No. 20.
What are Good "Seed" Potatoes? No. 21.
The Pink Spray for Apple Orchards, No. 22.
Diseases Carried by Seed Potatoes, No. 23.
The Calyx Spray for Apples, Pears, and Quinces, No. 24.
European Corn Borer Quarantine, No. 25.

The Apple and Thorn Skeletonizer, No. 26.
Registration of Bees, No. 27.
Winter Condition of Apple and Peach Buds, No. 28.
Dormant Sprays for Orchard Pests, No. 29.
Information about Insecticides and Fungicides, No. 30.
Why and How to Spray, No. 31.
Varietal Susceptibility of Apples to Diseases and Injuries, No. 32.
The Pre-Pink and Pink Sprays for Apples, No. 33.
Spray for the Imported Currant Worm, No. 34.
Tree Workers Holding Connecticut Certificates, No. 35.
The Calyx and Later Summer Sprays for Apples, No. 36.
Peach Spraying, No. 37.
Grape Spraying, No. 38.
The Apple and Thorn Skeletonizer, No. 39.
Spraying Shade Trees, No. 40.
The Oriental Peach Moth, No. 41.
Spraying Potatoes, No. 42.
The Apple Maggot or Railroad Worm, No. 43.
The Gipsy Moth Quarantine, No. 44.
Sun Scorch, Anthracnose, etc., of Shade Trees, No. 45.
Prematuring of Vegetables, Rots of Lettuce and Similar Troubles, No. 46.
Prematuring and Other Potato Troubles, No. 47.
Practical Lawn Suggestions, No. 48.
Regulations for Carrying Out the Provisions of the Law Concerning Concentrated Commercial Feeding Stuffs, No. 49.
Regulations Concerning the Shipment of Nursery Stock, and the New Law, No. 50.
Regulations Concerning the Transportation of Nursery Stock in the United States and Canada, No. 51.
A New Pest of Lawns, No. 52.
The Asiatic Beetle Quarantine, No. 53.
The Gipsy Moth Quarantine, No. 54.
The Asiatic Beetle Quarantine (Revision), No. 55.
The Japanese Beetle Quarantine, No. 56.
Regulations Concerning the Transportation of Nursery Stock in the United States and Canada, No. 57.
The Japanese Beetle Quarantine (Revision), No. 58.
The European Corn Borer Quarantine, No. 59.
Regulations for Carrying Out the Provisions of the Law Concerning Concentrated Commercial Feeding Stuffs, No. 60.
Regulations Concerning the Transportation of Nursery Stock in the United States and Canada (Revision), No. 61.

TOBACCO SUBSTATION[1]

Condensed Recommendations for the Control of Wildfire, No. 1.
Wildfire of Tobacco in 1922, No. 2.
Experiments in the Curing and Fermentation of Connecticut Shade Tobacco, No. 3.
Recommendations for the Control of Wildfire (Revision), No. 4.
Fertilizer Experiments with Tobacco, No. 5.
Report of Tobacco Station at Windsor for 1925, No. 6.
The Phosphorous Requirements of Old Tobacco Soils, No. 7.
Report of Tobacco Station at Windsor for 1926, No. 8.
Prolonging the Life of Tobacco Shade Tent Poles, No. 9.
Report of Tobacco Station at Windsor for 1927, No. 10.

[1] The separate series of the tobacco substation was discontinued in 1927, Bulletin 10 being the last. They now appear as bulletins of the regular station series.

ANALYTICAL CHEMISTRY

Reports of the Station

Station publications of the work of the analytical chemistry laboratory in the inspection of commercial fertilizers, foods, drugs and commercial feeding stuffs are to be found numbered consecutively in the annual reports. Each annual report from 1877 has published fertilizer analyses. Reports on foods begin with 1896. The first drugs report was in 1908. Yearly reports on inspection of commercial feeding stuffs begin with 1899, though analyses were published periodically from 1877 until that time. Inspection of insecticides may be found in the biennial report for 1907-1908 and in the annual reports for 1922, 1924 and 1925.

Journal Papers

Methods of Analysis of Commercial Fertilizers: Report of Committee on Phosphoric Acid.
E. H. Jenkins. U. S. D. A., Div. Chem., Bull. 7, 1885, 6-15.

Report on Potash.
E. H. Jenkins. U. S. D. A., Div. Chem., Bull. 24, 1890, 79-83.

Abstract of Chemical Literature Relating to the Analysis of Dairy Products.
E. H. Jenkins. U. S. D. A., Div. Chem., Bull. 28, 1890, 29-51.

The Use of Sodium Chloride in the Lindo-Gladding Method of Determining Potash.
A. L. Winton. U. S. D. A., Div. Chem., Bull. 31, 1891, 148-150.

Compilation of Analyses of American Feeding Stuffs.
E. H. Jenkins and A. L. Winton. Office of Experiment Stations, Exp. Sta. Bull. 11, 1892.

Report on Dairy Products.
A. L. Winton. U. S. D. A., Div. Chem., Bull. 38, 1893, 92-108.

Fat Content of Cream on Keeping With and Without Bichromate of Potash.
A. L. Winton. U. S. D. A., Div. Chem., Bull. 43, 1894, 192-193.

Some Conditions Affecting the Accuracy of the Determination of Potash as Potassium Platinichloride.
A. L. Winton. Jour. Am. Chem. Soc., 1895, XVII, 453-466.

Report on Potash.
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Bulletin 310 January, 1930

Connecticut Agricultural Experiment Station
New Haven

Canada-Leaming Corn

Donald F. Jones
W. Ralph Singleton

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THE TUTTLE, MOREHOUSE & TAYLOR COMPANY, NEW HAVEN, CONN.

CANADA-LEAMING CORN

As the result of many years of study of the effects of inbreeding and crossing upon corn the Connecticut Agricultural Experiment Station, at New Haven, produced a new type of corn called Double Crossed Burr-Leaming and first sent it out for trial in 1917. The history and development of this corn is given in the Connecticut Agricultural College Extension Bulletin No. 108. Burr-Leaming has been grown in an increasing amount since its first introduction and is well adapted to many parts of southern New England for grain and silage.

There are many parts of northern New England where Burr-Leaming and other varieties of a similar season will not mature properly for silage. To meet the need for a variety of corn which has a large stalk growth and heavy grain yield and which at the same time ripens sufficiently early to give a good quality of silage in short seasons, the Connecticut Agricultural Experiment Station has produced a new type of crossed corn called Canada-Leaming. This has been tested three years, 1927, 1928 and 1929. Farmers find it to be early maturing and high yielding.

A NEW TYPE OF CORN

Canada-Leaming is an entirely new type of corn, being a first generation hybrid of selected inbred strains of Canada Yellow flint and Leaming dent. It has long been known that crossing in both animals and plants gives an immediate stimulus to increased growth and greater yield in the first generation following the cross. This tendency to augment production is commonly called hybrid vigor. It has long been utilized in the mule, the sterile hybrid of the horse and the ass. Shorthorn-Angus and Shorthorn-Galloway crosses in cattle, Poland China-Chester White and Berkshire-Yorkshire crossbreds in swine and Shropshire-Merino combinations in sheep have been valued for many years and are becoming increasingly important. In all of these animals no attempt is made to use the crossbreds for breeding purposes. Animal husbandry-men have learned by long experience that these hybrids do not reproduce their own good qualities in their offspring. While the first cross is uniform in type, large, free from disease and fast growing, the second and later generations are variable, smaller, and often feeble and sometimes abnormal.

It has been demonstrated that this same principle of hybrid vigor which has long been used in animals can be applied to plants and particularly to corn. Plants have the added advantage that they can be put through a previous process of severe inbreeding

which rids them of many abnormalities and hereditary weaknesses that make their appearance from time to time in barren plants, nubbiny ears and stunted stalks.

QUALITIES OF FLINT AND DENT CORN

The eight-rowed flint corn now grown in New England is about the only type of this plant, still extensively used, that has come down from the Indians practically unchanged. It is raised in preference to dent corn where the growing season is short, where

FIG. 1. Canada-Leaming has the earliness of the flints and yields as much grain as many of the dents.

the spring is cold and wet, and where many of the days in mid-summer are cool. Under these conditions flint corn germinates better in early spring, starts with a more vigorous growth that gets ahead of the weeds and ripens into good sound grain before killing frosts come in the fall.

Dent corn is preferred wherever it can be properly matured on account of its large straight stalk that is free from tillers and its heavier production of grain where the growing season is long enough and sufficiently warm to permit its full development.

A first generation hybrid of the best of the New England flints with a suitable type of large, early-maturing dent corn, combining

many of the desirable features of both types with the advantage of hybrid vigor, would have value for New England conditions and other places having a similar season.

ORIGIN OF CANADA-LEAMING

An extensive corn variety test carried out by the Connecticut experiment stations at Storrs and at New Haven, reported in Bulletin 259 of the latter station, had shown many varieties of flint and dent corn to be well adapted to this part of the country. A Canada Yellow flint grown by E. E. Burwell of New Haven was selected as one of the best of the flints. Leaming grown for 20 years by Heman Beardsley at Roxbury, Connecticut was selected as a large, productive, dent corn that matured every year.

These two varieties were put through a process of inbreeding by self fertilization as described in Bulletins 266 and 273. Sixteen of the best of the inbred flint strains were selected for crossing. The strains were first crossed by pairs. Each of these first generation hybrids was then cross-pollinated by each of the others and the resulting seed mixed and planted in an isolated field. Selected ears from this mixture have been used to propagate the parental types from year to year. The original inbred strains were produced by hand pollination but this is now no longer necessary in multiplying seed.

A similar combination of the best inbred strains of Beardsley's Leaming was made in the same way. Both of these re-synthesized varieties are about the same in general appearance as the original varieties but yield somewhat more and are freer from hereditary defects and abnormalities.

PRODUCING CROSSED SEED

The Canada Yellow flint stock, produced in this way, is used as the seed parent while the Leaming stock produces the pollen. In practice, two rows of the flint are planted with one row of the dent alternating throughout the field. Both kinds of seed are planted at the same time. The tassels on the flint plants are all pulled out before pollen is shed. This very important task is somewhat tedious, but it is the only way that crossed seed corn can be produced at present. When the silks appear on the detasseled plants, pollen has just begun to be shed by the dent pollen parent, planted solely for that purpose in every third row.

Care is necessary in planting to make sure that the pollinator plants are properly distributed throughout the field. It is also essential that they produce pollen at exactly the right time. Furthermore, the tassels of the flint seed parent must be removed before they produce any pollen; otherwise part of the seed will not be crossed.

All of the ears borne on the dent pollinator plants are self bred and can not be used as crossed seed. Stock seed of both parental types is maintained in separate fields. Although seed from the pollinator plants can be used for planting the pollen producing rows in the crossing field another year, it is not advisable to use this seed for that purpose. It is practically impossible to get all of the tassels on the seed parent pulled out at the right time. In spite of careful attention some pollen will be produced. This will contaminate the pollen parent and if this seed is used continuously such mixing may destroy the type.

For all these reasons it will be appreciated that crossed corn seed costs considerably more to produce than ordinary seed. Silage corn seed as now obtained in common practice is grown in the western states from seed that may or may not have been grown in the east the year previous. Unless the stock seed is grown under proper supervision in the east and the fields grown for seed guarded against cross-pollination with unadapted varieties no dependable supply of seed corn can be maintained.

The question now before us is: does this method of producing crossed seed give sufficiently greater yields of grain and silage over an average period of years to justify the increased cost of the seed?

CHARACTERISTICS OF CANADA-LEAMING

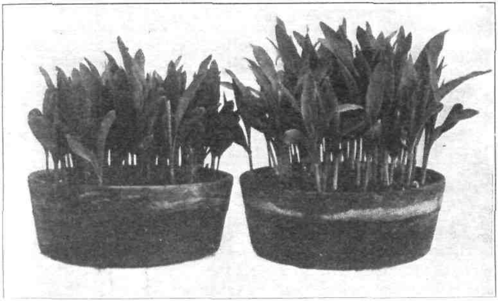
Using the flint type to produce the seed kernel has a distinct advantage. The plants ripen early in southern Connecticut, the grains are plump, hard, bright and dry out thoroughly, practically every year before cold weather. This insures a good quality of seed corn—a matter of prime importance with any seed. The cross-bred flint kernels germinate better and the young seedlings grow more vigorously than those of the dent type, as shown in Figure 2. Planted at the same time, in the same soil and treated exactly alike the two lots of seedlings are quite different in size within a few days after they are up. This difference is easily apparent in the field where dent corn is grown by the side of Canada-Leaming and this quick start is an advantage in permitting early cultivation, thereby getting ahead of the weeds.

At New Haven, Canada-Leaming produces strong, sturdy stalks from 8 to 9 feet tall and usually one or more tillers. These side branches vary in size from a few inches to the height of the main stalk depending on the thickness of planting and the seasonal conditions. When planted 4 stalks to the hill with the hills 3′ by 3′ or the equivalent in drilled rows, few tillers are formed. Where the corn is grown for grain 3 stalks in the hill spaced 3.5′ by 3.5′ will give better developed ears.

Usually one large ear is produced on each stalk with many

having two or more. Very few barren stalks and nubbins are found in crossed corn where the soil and season are favorable and this is the big advantage of crossed seed based on inbred strains over ordinary seed corn.

The ears of this flint-dent combination are from 8 to 12 inches long with usually 12 rows of smooth, round kernels showing a slight indentation. They are intermediate in form between the flint and the dent kernel, but are somewhat more like the flint in hardness and texture. The kernels are not so large as the flint and are better adapted for feeding whole to poultry.



Leaming Canada-Leaming

FIG. 2. The flint type of kernel gives Canada-Leaming a quick start in the spring.

EARLY MATURITY

Canada-Leaming ordinarily matures for grain in about 100 to 110 days when planted the latter part of May in southern Connecticut. It often can be cut and shocked before this time and give corn that will cure properly in the crib. In maturity it is fully as early as the medium-sized flints of the Canada Yellow type although it is not as early as some of the small-eared strains of early-maturing flint corn.

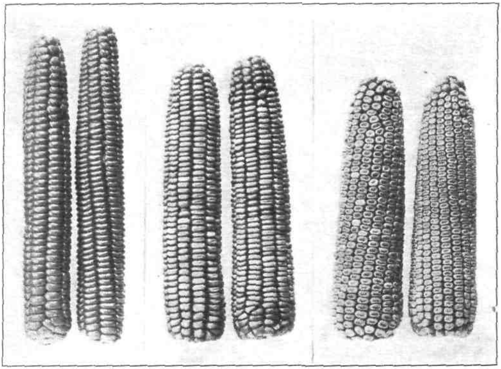
YIELD OF GRAIN

In two years trials at Mt. Carmel Canada-Leaming has yielded more dry shelled grain than any variety of flint or dent ripening

within two weeks of the same time. These yields in bushels to the acre are as follows:

	1927	1928
Canada-Leaming	60.5	56.3
Canada Yellow Flint	44.8	39.6
Sanford White Flint	45.8	46.4
Gold Nugget	...	47.7
Century Dent	...	55.4

1928 Canada-Leaming was grown in the experiment station trials at Storrs, Connecticut, and yielded 3,430 pounds of ear corn in comparison with 2,853 pounds for Pride of the North, based on an average of six plots each.



Canada Flint Canada-Leaming Leaming Dent

FIG. 3. Canada-Leaming is the result of crossing, each year, Canada Yellow flint and Leaming dent.

In New York, Canada-Leaming was included in all of the regional tests in 1928. A report from R. D. Lewis states that, "as in 1927 it was outstanding in its performance in its maturity class. It is approximately the same maturity as, possibly a very little later than Hall's Gold Nugget, but decidedly superior to it. This is quite evident from an inspection of the summary table." The table follows:

Silage Corn Variety Test in Ten Counties in New York in 1928

	Dry weight tons per acre	Shelled grain pounds per acre
Eureka	4.30	251
Canada-Leaming	3.98	2721
West Branch Sweepstakes	3.90	2020
Cornell No. 12	3.77	2106
Cornell No. 11 (Morse)	3.63	2752
Golden Glow (Wis. No. 12)	3.63	2565
Luce's Favorite	3.31	1527
Leaming	3.30	1352
Golden Glow	3.27	2273
Alvord's White Cap	3.16	2521
Minnesota No. 13	2.77	2319

Reports have been received from 20 farms where Canada-Leaming was grown in 1928 and 1929 in Vermont, New Hampshire, Maine, Massachusetts and Connecticut, usually in comparison with other varieties. In all but two of these trials this crossed corn was considered to be superior in one or more respects to the corn grown in comparison with it. A few of the comments are as follows:

R. A. Burroughs, Vergennes, Vermont, 1928.—"Planted Eureka, Sweepstakes, Mammoth Yellow Flint, Burr-Leaming, Lancaster Sure Crop and Canada-Leaming this year on heavy clay with light coat of manure and 100 pounds of acid phosphate broadcast. We checked it up before harvesting about September 15 and decided that the Canada-Leaming was the best of all, well matured and eared and glazed, even though we were unable to plant it until late."

G. W. Wilder, Timber Top Farm, East Rindge, New Hampshire, 1929.—"Owing to rains, etc., we did not get the Canada-Leaming into the ground until around June 1. We got by far the best ensilage corn we have had in three years, though the season was not a good growing one. The stalks grew 10 to 12 feet high; the ears were, many of them, mature and all were in milk, though we began cutting around September 15. No one had ever seen better ensilage corn growing around here."

E. M. Brown, Waterville, Maine, 1929.—"I tried Canada-Leaming by the side of Mammoth flint. It had about 90 days to grow. Canada-Leaming had about the same fodder, more ears and was eight days earlier."

J. H. Putnam, Greenfield, Massachusetts, 1929.—"We tried out the Canada-Leaming for the second year in 1929 and found it very satisfactory. We are very much impressed with it, especially on our lower hill soils, due to the fact that it carries so large a percentage of grain."

FIG. 4. Canada-Leaming has strong, sturdy stalks from 8 to 9 feet tall.

Based upon its behavior in 1927, 1928 and 1929, it seems that Canada-Leaming has a useful place where an early maturing, high yielding corn of good grain quality is desired. In northern New England and northern New York, it can be grown advantageously wherever Gold Nugget, Mammoth Flint, Luce's Favorite and some of the early dents are now grown. In southern New England and in many places in New York State it can be ripened for grain and can be expected to give a larger yield and better maturity than Pride of the North, Century Dent, Canada Yellow Flint, Sanford White Flint or other varieties of a similar season.

While the production of crossed corn seed involves more care and attention to details and additional labor the process is relatively simple. It can be grown for seed only in those parts of the country where the flint type can be thoroughly matured and dried every year before cold weather. Any one interested in producing seed of Canada-Leaming corn should write to the Connecticut Agricultural Experiment Station at New Haven. Names of growers of seed will also be sent on request.

Bulletin 311 January, 1930

TOBACCO SUBSTATION AT WINDSOR

REPORT FOR 1929

P. J. ANDERSON, T. R. SWANBACK, O. E. STREET
AND OTHERS

Connecticut
Agricultural Experiment Station
New Haven

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CONTENTS

	Page
Potash fertilizer experiments	207
Quantitative series	207
Comparison of carriers	210
The use of manure as a supplement to commercial fertilizer	216
Effect of manure on soil acidity	217
Effect of manure on the burn	218
Hyper Humus	220
Greenhouse experiments	220
Field experiments	223
Burn tests	225
Seed bed experiments	225
Discussion of results	226
Chemical composition of a poor burning tobacco crop compared with a good burning crop	228
Alkalinity of the water soluble ash	230
Chemical investigations of tobacco	234
The bases of tobacco extracts	235
Nitrogen distribution in germinated and ungerminated seed	241
The occurrence of nitrate nitrogen in tobacco	243
Field experiments on brown rootrot	247
Occurrence and symptoms	247
Cause	248
Plan and purpose of the experiment	248
Effect of preceding crops	250
Continuous tobacco	252
Fall plowing	252
Manure	252
Acid fertilizer	253
Lime	253

Page

Fallow 254

Sterilizing the soil 254

Summary 255

Recommendations 255

Black rootrot resistant shade tobacco 256

Symptoms of black rootrot 257

Importance of black rootrot to the shade industry 258

Origin of the 4R resistant strain 258

Further testing of the 4R strain in 1928 259

Continuation in 1929 261

Seasonal fluctuations in soil reaction 264

Single nitrogen source plots at Windsor 264

Seasonal trends in concrete-walled soil plots at New Haven 265

Nitrate content of the soil as a factor in seasonal fluctuations 265

Conclusions from pH fluctuation studies 268

Damping-off of young seedlings 269

Raising tobacco by tractor 271

Cel-o-glass seedbed sash 273

REPORT OF THE TOBACCO SUBSTATION FOR 1929[1]

The tobacco season of 1929 was marked, first, by exceptionally low rainfall during the growing period and, second, by the most destructive single hail storm in the history of the valley.

Rainfall for the critical months of June and July, and the less critical August, for 1929, as compared with the average of the last half century, was:

	June	July	August
Rainfall in 1929	1.67	.98	4.87
Average rainfall for 57 years	3.09	4.36	4.39

More than half of the August rainfall was during the hailstorm of August 1. Thus, both the amount of rainfall and its distribution were unfavorable to production of a good crop of tobacco. The most noticeable effects of this dry season on the quality were more prominent veins and heavier leaves. The actual yield of the crop in pounds to the acre was therefore greater than would have been anticipated from a field inspection.

After the destructive hail, State Commissioner of Agriculture Buckingham made a farm to farm survey, from which we quote the following figures on the extent of the damage:

The total tobacco loss due to hail was more than $2,359,000 on the 715 farms which furnished complete information. Of this $391,000 was shade-grown tobacco, $1,750,000 was Broadleaf and $218,000 was Havana Seed (Table 1).

TABLE 1. TOBACCO HAIL DAMAGE BY VARIETIES

Variety	Acres affected	Amount of damage
Broadleaf	6,613	$1,749,840
Shade-grown	2,438	391,282
Havana Seed	1,045	218,354

In the case of shade-grown tobacco, the first picking and part of the second had been finished before the storm, so that the most valuable part of the crop was saved. It is estimated that, on farms within the hail area, 16 percent of the total value of the shade-grown crop was lost.

Broadleaf and Havana Seed tobacco suffered much more severely, with losses of 88 per cent and 70 per cent, respectively, of the total value of the crop. The proportion of the loss covered by insurance was so small as to be almost negligible.

[1] For bibliographical purposes all material should be credited to P. J. Anderson, T. R. Swanback and O. E. Street, unless otherwise indicated.

The storm ranged over ten towns, but the greatest devastation fell in South Windsor and East Hartford.

TABLE 2. TOBACCO HAIL DAMAGE BY TOWNS

Town	Amount of damage
South Windsor	$907,000
East Hartford	658,000
Windsor	163,000
Glastonbury	153,000
Manchester	111,000
Bloomfield	89,000
East Windsor	86,000
Simsbury	79,000
Vernon	70,000
Ellington	43,000

FIGURE 5. This was a promising shade field before the hail storm.

A summary by towns of the figures made public by Commissioner Buckingham appears in Table 3.

Tobacco on all the experimental plots at Windsor was completely destroyed. All data for the year on these plots is confined to observations on growth before August 1. On the shade tobacco, however, the first three primings, 11 leaves, had been harvested and they furnished valuable information for the experiments on selection and breeding.

TABLE 3. HAIL LOSS BY TOWNS AND VARIETIES

Town	No. farms affected	Shade-grown Per cent damage	Shade-grown Loss (dollars)	Broadleaf Per cent damage	Broadleaf Loss (dollars)	Havana seed Per cent damage	Havana seed Loss (dollars)
Bloomfield	24	10	51,000	100	3,000	71	24,569
East Hartford	163	37	120,852	94	503,279	100	34,500
East Windsor	36	15	14,250	54	70,501	45	1,350
Ellington	15	10	17,500	47	17,343	60	8,100
Glastonbury	96	0	0	64	142,997	54	10,187
Manchester	63	0	0	90	93,524	96	16,128
Simsbury	35	8	51,460	70	2,100	51	25,298
South Windsor	235	75	52,500	97	854,975	0	0
Vernon	25	15	22,500	96	43,776	100	4,800
Windsor	90	13	51,220	56	18,345	68	93,432
Total	782	16	391,282	88	1,749,840	70	218,364

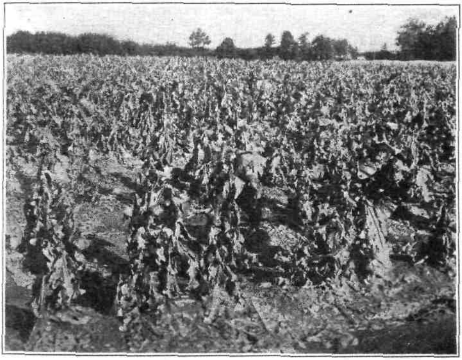

FIGURE 6. What the hail storm did to a good crop of Havana Seed tobacco.

One addition has been made to the scientific staff of the tobacco station. O. E. Street was appointed physiologist of the station July 1. He is engaged in biochemical investigations, in which his major study is the development of colors during the curing process.

Mention should be made here of the excellent tobacco research by members of the experiment station staff outside of the tobacco substation, and by the Connecticut Agricultural College staff:

Dr. E. M. Bailey and others of the analytical chemistry department made the numerous chemical analyses of tobacco which have

been published in our reports. Their fertilizer analyses are also of inestimable value to the growers.

Dr. H. B. Vickery and Dr. G. W. Pucher have reported important progress in investigations of the nitrogenous constituents of the tobacco leaf and their transformation during the curing process.

M. F. Morgan and other members of the soils department have made notable contributions in their soil and nutrition studies on tobacco in the last five years.

Professor Davis and Professor Hendrickson of the college economics department are conducting an investigation of the economics of tobacco production and more recently Professor

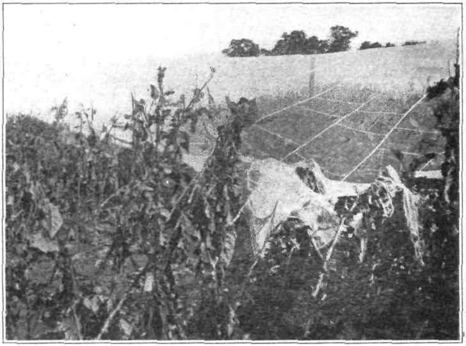

FIGURE 7. Shade tobacco tent on the experiment station farm after the hail storm.

Boyd of the same department has begun a thorough study of the marketing problems of the tobacco industry.

The extension department has again contributed the part-time services of J. S. Owens in conducting curing demonstrations. There is; however, need for more extension work among the tobacco farmers.

The most important addition to the physical equipment of the tobacco substation during the year is an extensive system of lysimeters installed by the soils department. This affords means to study and measure plant food elements lost by leaching. The lysimeters have been in operation since June 1 and they are

FIGURE 8. Broadleaf after the hail storm.

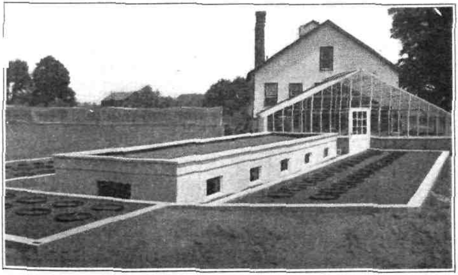

FIGURE 9. Exterior view of the lysimeters.

yielding interesting information which will be published in later reports. Illustrations are printed in Figures 9 and 10.

Other improvements are a garage and the addition of an adjacent acre for experiments.

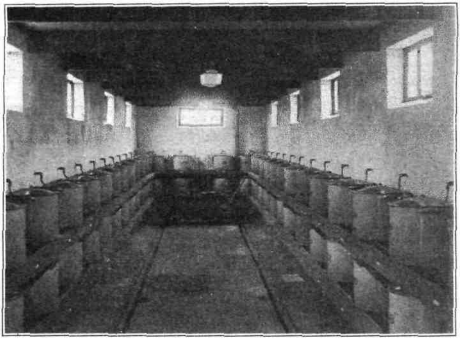

FIGURE 10. Interior of lysimeter pit.

Despite the loss of considerable data on the fertilizer and cover crop plots through the storm, the year has been one of steady improvement and of progress in a number of lines of investigation, the most important of which are summarized in this report.

POTASH FERTILIZER EXPERIMENTS

Some observations and previously unrecorded data on the potash experiments in progress at the tobacco substation have accumulated since our last report.

QUANTITATIVE SERIES

Field growth. A comparison during the 1929 growing season of the plots which had received 300 pounds, 200 pounds or 100 pounds of potash to the acre showed no marked differences in growth. However, on those plots to which no potash had been applied, except for 28 pounds to the acre in the organic fertilizer material, growth was noticeably smaller and leaves were less luxuriant. These plots never showed any acute symptoms of potash hunger, but on hot days they could be picked out readily from the others, because of their wilted and flagging leaves, a symptom which has been observed in previous seasons on the no-potash plots.

Effect of quantity of potash on fire holding capacity of the leaves. Samples of four grades of leaves from the plots of 1928 were force-sweated and aged until September, 1929, when strip burn tests were made in the usual manner, as described in previous reports. Results of these tests on the old series (third year of the experiment) are presented in Table 4 and a summary of the first three years is given in Table 5.

TABLE 4. OLD QUANTITATIVE POTASH SERIES ON FIELD V. STRIP BURN TESTS FOR CROP OF 1928

Quantity of K_2O applied	Plot No.	Duration of burn (seconds) Darks	Mediums	Lights	Seconds	Average for Plot	Treatment
None	K11	15	..	..	19	17	21
	K11-1	24	..	..	26	25	
100 lbs. to acre	K12	48	39	44	49	45	41
	K12-1	43	38	34	30	36	
200 lbs. to acre	K9	50	47	53	53	51	51
	K9-1	44	54	55	47	50	

TABLE 5. SUMMARY OF THREE YEARS RESULTS ON THE ABOVE PLOTS

Quantity of potash	Average burn for crop of 1926	1927	1928	All
None	39	36	21	32
100 lbs. to acre	40	57	41	46
200 lbs. to acre	45	56	51	51

These data show that the fire holding capacity grows less every year on the no-potash plots. For the first year, the decline was hardly noticeable; it was very apparent for the second year and still more so the third. On the plots which had 100 pounds K_2O to the acre, *there was no ill effect on the fire holding capacity the first two* years, but a decided drop in the third. The burn has been maintained throughout on the 200 pounds plots. In making these tests, it was observed that the ash on the no-potash plots was whiter than on the others. This was probably due to the increase of calcium and magnesium in the leaf when the potash content was reduced.

Similar burn tests were then made on tobacco from the more recent series of potash plots on Field I. Results of these tests (second year) are presented in Table 6. The fertilizer treatment

Table 6. New Quantitative Potash Series on Field I. Strip Burn Test for Crop of 1928

Quantity of K_2O to acre	Plot No.	Duration of burn (seconds) for Darks	Mediums	Lights	Seconds	Average for Plot	Average for Treatment
	K11-2	34	37	44	45	40	
	K11-3	34	45	33	38	38	
	K11-4	39	49	44	45	44	
None	K11-5	14	32	21	32	27	37
	K12-2	50	40	47	43	45	
100 lbs.	K12-3	54	59	53	58	56	52
	K12-4	53	54	57	56	55	
	K9-2	55	54	58	54	55	
	K9-3	56	54	56	52	54	
	K9-4	55	56	59	53	56	
200 lbs.	K9-5	34	49	55	52	48	52
	K9-6	43	58	59	56	54	
	K9-7	53	53	48	49	51	
	K9-8	26	44	48	55	43	
	K13	35	48	50	49	46	
	K13-1	41	40	56	46	46	
300 lbs.	K13-2	44	52	57	51	51	51
	K13-3	55	57	58	58	57	
	K13-4	55	48	53	59	54	

of these plots is a replication of that on the older quantitative series previously mentioned, but with the addition of five plots on which 300 pounds potash to the acre were applied. As far as fire holding capacity is concerned, the results for the first two years duplicate those of the older series. That is, on the no-potash plots there is a slight decline in fire holding capacity the first year and a much more decided drop the second year. The other plots show no impairment in this respect during the first two years. Raising the rate of application to 300 pounds an acre has had no effect on the burn. Neither has this excessive quantity of potash pro-

duced any beneficial influence on the yield or quality of the crop, as was mentioned in our report for 1928.

Influence of quantity of fertilizer potash on chemical composition of the leaves. Sample hands of two grades (darks and seconds) from the first and second crops of the older quantitative series were analyzed by the department of chemistry to see to what extent an increased amount of fertilizer potash would influence the potash absorption of the leaf. These analyses are presented in Table 7. Since previous analyses at this station and elsewhere have shown that the quantity of other mineral bases in the leaf may also be affected by the amount of potash, calcium and magnesium were also determined.

TABLE 7. INFLUENCE OF QUANTITY OF FERTILIZER POTASH ON POTASH, LIME AND MAGNESIA IN THE LEAF

			Percentage of							
			Potash (K_2O)				Lime (CaO)		Magnesia (MgO)	
Amount of K_2O to acre in fertilizer	Plot No.	Grade	1926	Ave.	1927	Ave.	1927	Ave.	1927	Ave.
None (except 28 lbs. in organics)	K11	D	6.96	7.00	5.46	5.46	5.33	5.74	0.85	0.94
	K11	S	7.03		4.71		7.02		1.09	
	K11-1	D			6.00		4.28		0.78	
	K11-1	S			5.67		6.33		1.03	
100 lbs. total	K12	D	7.20	7.27	7.19	7.00	4.25	5.18	0.69	0.82
	K12	S	7.33		7.18		6.00		0.93	
	K12-1	D			7.06		4.42		0.74	
	K12-1	S			6.58		6.04		0.92	
200 lbs. total	K9	D	7.97	8.15	7.69	7.64				
	K9	S	8.32		7.97					
	K9-1	D			7.81					
	K9-1	S			7.10					

From a study of this table we may conclude that:

1. *The percentage of potash in the leaf is materially affected by the quantity applied in the fertilizer—even though this soil contains an enormous natural reserve of potash.*

2. *The deficiency of potash in the leaf from the no-potash plots becomes more pronounced during the second year than the first.*

3. *One hundred pounds of potash to the acre in the fertilizer result in a deposit of less potash in the leaves than 200 pounds to the acre, but the deficiency during the second year is not more pronounced than during the first year.*

4. *Decrease in potash is accompanied by increase in both calcium and magnesium in the leaf. That is, the smaller the percentage of potash, the greater the percentage of calcium and magnesium (always one or both).*

In the 1927 "no-potash" samples the potash: calcium ratio was approximately 1:1. All previous analyses of tobacco from plots

on the station farm have shown a ratio in which the potash figure was greater than 1.

5. *There is a general relation between fire holding capacity, as measured by the strip test, and the ratio of potash on the one side to calcium and magnesium on the other. The wider the ratio, in favor of potash, the longer the burn.*

There is, however, a danger of placing too much emphasis on this point. In the first place, it has been shown that in high-lime tobacco, the burn on the cigar is much better than the strip test would indicate, not only in duration but also in closeness of burn, aroma and taste. In the second place, too much potash may cause a dark charred ash, while an increase in calcium or magnesium will make the ash white and more porous. The optimum ratio of these mineral bases in cigar leaf tobacco has not yet been fully established.

COMPARISON OF CARRIERS

In 1929, potash from five different carriers was compared. They were sulfate, nitrate, carbonate, tobacco stems, cottonhull ash, and various combinations of these. As far as could be judged in the field, no significant differences in the tobacco raised on these could be observed.

Effect of different carriers on fire holding capacity. Strip burn tests were made on the fermented samples of the 1928 crop in the same manner as mentioned above for the quantitative series. Results of the tests on the old qualitative series are presented in Table 8 and the average results for four years in Table 9. The differences in fire holding capacity are small. It may be significant, however, that during each of the four years the duration of burn for the carbonate plots has been somewhat the highest. Also, with one exception, the shortest burn has been on the sulfate plots.

TABLE 8. OLD QUALITATIVE SERIES ON FIELD V. STRIP BURN TEST FOR CROP OF 1928

Carrier	Plot No.	Duration of burn (seconds) for Darks	Mediums	Lights	Seconds	Average for Plot	Treatment
Sulfate	K1-2	51	50	49	47	49	46
	K1-3	42	47	39	48	44	
Carbonate	K5	52	58	60	56	57	56
	K5-1	56	53	58	..	54	
Nitrate ⅔	K7	59	54	53	56	56	54
Carbonate ⅓	K7-1	53	50	54	58	54	
Sulfate ½	K8	57	44	59	54	54	53
Carbonate ½	K8-1	53	47	53	56	52	
Sulfate ⅓ Carbonate ⅓ Nitrate ⅓	K9 K9-1	50 44	47 54	53 55	53 47	51 50	51

TABLE 9. OLD QUALITATIVE POTASH SERIES ON FIELD V. SUMMARY OF STRIP BURN TESTS FOR FOUR YEARS

Carrier	Plots	Average duration of burn in— 1925	1926	1927	1928	All four
Sulfate	K1-2 K1-3	36	44	53	48	45
Carbonate	K5 K5-1	45	49	56	55	51
Nitrate ⅔ ...... Carbonate ⅓	K7 K7-1	43	41	53	54	48
Sulfate ½ ...... Carbonate ½	K8 K8-1	38	42	55	53	47
Sulfate ⅓ .... Carbonate ⅓ .... Nitrate ⅓	K9 K9-1	43	45	55	51	49

Results of the tests on the more recent series of potash plots on Field I, presented in Table 10, are similar to those of the older

TABLE 10. NEW QUALITATIVE POTASH SERIES ON FIELD I. STRIP BURN TESTS FOR CROP OF 1928

Source of Potash	Plot No.	Duration of burn (seconds) for Darks	Mediums	Lights	Seconds	Average for Plot	Treatment
Sulfate	K1-4	33	45	54	56	47	51
	K1-5	38	44	.	49	44	
	K1-6	36	54	58	51	50	
	K1-7	40	..	..	46	43	
	K1-8	50	59	56	60	56	
	K1-9	60	56	59	57	58	
Carbonate	K5-2	58	..	60	54	57	54
	K5-3	45	59	59	60	56	
	K5-4	45	45	57	54	50	
Nitrate ⅔ ...... Carbonate ⅓	K7-2	53	52	49	49	51	52
	K7-3	38	56	57	57	52	
	K7-4	51	52	..	..	52	
Sulfate ½ ...... Carbonate ½	K8-2	27	48	55	52	46	49
	K8-3	33	34	52	56	44	
	K8-4	50	58	60	59	57	
Sulfate ⅓ ...... Carbonate ⅓ .... Nitrate ⅓	K9-2	55	54	58	54	55	52
	K9-3	56	54	56	52	54	
	K9-4	55	56	59	53	56	
	K9-5	34	49	55	52	48	
	K9-6	43	58	59	56	54	
	K9-7	53	53	48	49	51	
	K9-8	26	44	48	55	43	
Stems	K14	54	51	54	52	53	53
	K14-1	47	51	..	55	51	
	K14-2	54	57	51	56	54	

series. Again carbonate is at the top, but the differences in fire holding capacity between the treatments seem too small to be of much significance. Three plots which received all their potash in stems were included in this series. The fire holding capacity on these was as good as the others.

Summing up all the information we have obtained up to date on fire holding capacity as measured by the strip test, we may say that the differences produced by use of sulfate, carbonate, nitrate or tobacco stems or various combinations of the above are very small; possibly too small to be of consequence, if any one of the potash carriers is preferable from the standpoint of price, convenience in mixing, or the like.

Effect of different potash carriers on chemical composition of tobacco. Two questions occur as to the effect of different potash carriers on the composition of tobacco: First, does the leaf absorb more potash from one carrier than from another? Second, is the percentage of sulfur in the leaf increased when sulfate is used in the fertilizer? Samples of darks and seconds from the fermented crop of 1927 were analyzed by the chemistry department for sulfur and potash. As far as the amount of potash absorbed is concerned, these data, presented in Table 11, show that the differences are very small and not constant. There is no indication that tobacco will actually take up more potash from one carrier than from another.

TABLE 11. OLD QUALITATIVE POTASH SERIES. PERCENTAGE OF POTASH AND SULFUR IN CROPS OF 1926-1927

			Percentage (air dry basis) of								
			Total sulfur (S)			Sulfate (S)		Organic	Potash (K_2O)		
Source of potash	Plot No.	Grade	Crop of 1927	Ave.	1926 Ave.	1927	Ave.	Sulfur 1927	1927	Ave.	1926 Ave.
Sulfate	K1-2	D	0.50	0.49	0.57	0.36	0.36	.14	7.27	7.83	8.49
	K1-2	S	0.43			0.29		.14	7.53		
	K1-3	D	0.56			0.42		.14	8.13		
	K1-3	S	0.48			0.37		.11	8.40		
Carbonate	K5	D	0.43	0.42	0.46	0.28	0.28	.15	7.16	7.60	8.13
	K5	S	0.38			0.24		.14	7.65		
	K5-1	D	0.44			0.31		.13	7.82		
	K5-1	S	0.42			0.29		.13	7.76		
Nitr. ⅔ Carb. ⅓	K7	D	0.45	0.43	0.43	0.31	0.29	.14	7.36	7.80	8.50
	K7	S	0.41			0.28		.13	7.85		
	K7-1	D	0.47			0.32		.15	7.98		
	K7-1	S	0.39			0.26		.13	8.02		
Sulf. ½ Carb. ½	K8	D	0.47	0.46	0.52	0.32	0.33	.15	7.69	7.82	8.13
	K8	S	0.44			0.31		.13	7.67		
	K8-1	D	0.51			0.38		.13	7.85		
	K8-1	S	0.42			0.29		.13	8.08		
Sulf. ⅓ Carb. ⅓ Nitr. ⅓	K9	D	0.44	0.45	0.54	0.31	0.32	.13	7.69	7.64	8.15
	K9	S	0.41			0.29		.12	7.97		
	K9-1	D	0.51			0.36		.15	7.81		
	K9-1	S	0.46			0.33		.13	7.10		

The data on sulfur, however, are of more interest and importance. Sulfur occurs in two forms in the tobacco leaf. In the organic form it is a necessary constituent of the protoplasm. In the inorganic form it occurs as sulfate, probably combined mostly with potash as a base. In this latter form it is objectionable since it reduces the amount of potash which is free to combine with organic acids—it is only in the latter combination that potash promotes burn. It is therefore important to reduce as much as possible the inorganic or sulfate form. A study of the table shows first of all that the quantity of organic sulfur is remarkably constant (about .13 per cent of the dry weight of the leaf) and does not vary with the source of fertilizer potash. But the sulfate sulfur shows considerable variation, depending on the amount of this element which was applied in the fertilizer. Comparing for example the carbonate plots of 1927 with the sulfate plots of the same year, the sulfate sulfur was increased about one-third by application of sulfate of potash in the fertilizer. In other words, any sulfur which is added in the fertilizer will appear only as increased sulfate in the leaf. It is unnecessary in the development of the plant and calls for additional potash in order to keep up the burn. *Although a certain small amount (.13 per cent) of sulfur is* necessary to the growth of tobacco, there is no need to apply any extra sulfur in the fertilizer, since the plant will always be able to satisfy its needs from the soil sulfur or the sulfur which is unavoidably added in the organics of the fertilizer mixture.

The somewhat reduced fire holding capacity which has been found in the sulfate plots, as compared with the carbonate, is probably due to this small increase in sulfate sulfur. From the standpoint of good combustion it is probably fortunate that the ability of the tobacco plant to absorb increased quantities of sulfur is very limited. None of the analyses which have been made on Connecticut Valley tobacco show a sulfur content as high as one per cent while most of them come close to .5 per cent. In this respect, sulfur is in sharp contrast to chlorine, which the plant may absorb in large amounts, following rather regularly the quantity which has been applied to the soil.[1] Phosphorus, the third mineral acid element of the plant, acts more like sulfur. In fact, phosphorus is even more constant and it is difficult to change the percentage which occurs in the leaf, no matter how much is applied to the soil.

Jenkins, according to the report of the experiment station for 1896, page 328, found much greater differences in sulfur content between the tobacco grown with sulfate of potash and that grown

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[1] In some recent Kentucky experiments (Kentucky Agricultural Experiment Station Report, 41:17) the chlorine content of tobacco was raised from .048 per cent in unfertilized tobacco to 6.5 per cent in tobacco where 800 pounds KCl to the acre were used in the fertilizer.

with carbonate. The percentage of sulfur in the ash of the first was two to four times as much as that in the latter. This was accompanied by similar differences in fire holding capacity. Ames and Boltz (Ohio Agricultural Experiment Station Bulletin 285, page 187) also found both total sulfur and sulfate sulfur increased in the leaf when sulfate of potash was used. The same was true when other carriers of sulfur, such as superphosphate and sulfate of ammonia, were used.

Concerning increase in the sulfur content of Burley tobacco from increased application of sulfate of potash, we quote from the 1928 report of the Kentucky experiment station, page 17, "The percentage of sulfur in the tobacco increased with increasing applications of potassium sulfate, but at a much lower rate than in the case of chlorine, the range being from .4 per cent in the unfertilized tobacco to 1.187 per cent in tobacco fertilized with 800 pounds per acre of potassium sulfate."

From the consensus of data from all available sources, both in the Connecticut Valley and elsewhere, the following principles with regard to sulfur for tobacco may be regarded as thoroughly established.

1. *From a growth standpoint, the addition of sulfur in the fertilizer mixture is unnecessary.*
2. *Applications of sulfates to the soil increase the percentages of sulfates which will appear in the leaves.*
3. *Sulfates in the leaf are injurious to the burn.*

In view of these facts it is best to avoid in the fertilizer all materials containing considerable percentages of sulfur unless there should be some very distinct advantage from some other standpoint in using them.

Effect of potash carriers on soil reaction. This subject was discussed in some detail in the report for 1928. There remains to be added only the results on the fifth year of the series. This

TABLE 12. REACTION OF POTASH PLOTS IN 1929

Source of potash	Plot No.	Reaction of soil 1925 May 20	1929 May 20	1929 June 20	1929 July 2	1929 July 20	1929 August 20
Sulfate	K1-2	6.02	5.91	5.00	5.12	5.43	5.92
	K1-3	5.09	5.06	4.25	4.32	4.96	4.76
Carbonate ..	K5	5.53	5.56	4.83	4.80	4.98	5.23
	K5-1	5.21	5.11	4.50	4.39	5.12	4.96
Nitr. ⅔	K7	5.31	5.13	4.43	4.55	4.92	5.17
Carb. ⅓	K7-1	5.30	5.15	4.18	4.35	4.49	4.56
Sulf. ½	K8	5.26	5.32	4.50	4.60	4.92	4.93
Carb. ½	K8-1	5.10	5.30	4.25	4.42	4.76	4.73
Sulf. ⅓ .... Carb. ⅓ .... Nitr. ⅓	K9	5.05	5.21	4.73	4.71	5.21	5.07
	K9-1	5.05	5.18	4.32	4.30	4.76	4.83

year it was thought best to determine reaction, not only immediately before and after removal of the crop, but also at several times in the growing season. The results for 1929 are presented in Table 12.

The samples of 1925 were taken before the experiment was started, immediately before application of fertilizer. The corresponding May samples for 1929 were also taken before application of fertilizers, four years after the first series of samples. Comparing these two columns it appears that the various treatments of the four intervening years have had little effect on the soil reaction.

FIGURE 11. Side dressing the growing crop with wheelbarrow fertilizer sowers.

It will be noticed that during the remainder of the summer, all the plots were unusually acid, a condition which was not confined to these plots but was general throughout the state. The very dry summer following two years of heavy rainfall probably had some influence here. There was considerable variation in reaction up and down during the summer but no consistent tendency of any one treatment to make the soil more acid or less acid than the others.

We are justified in concluding, therefore, from all the results obtained through this five-year test that when sulfate, carbonate, nitrate or various combinations of them are used to supply 200 pounds of potash an acre, none of them will produce any significant change in reaction of a soil of this type.

THE USE OF MANURE AS A SUPPLEMENT TO COMMERCIAL FERTILIZER

In previous reports of this station,[1] field tests on the value of manure when used *in addition to* the regular application of commercial fertilizer have been described. Yield and sorting records for the first three years of the experiment show that in general there has been an improvement, both in yield and percentage of better grades, from the use of either stable manure or artificial (adco) manure on our sandy soil. The improvement was greater during the wet years of 1927 and 1928, but was only slight in the comparatively dry year of 1926, the first year of the experiment.

The extremely dry season of 1929 presented an opportunity for observing the effect of annual applications of manure on growth during that type of a season, even though yield and sorting data were prevented by the hail storm. On all the manure plots, both stable and adco, the plants were badly stunted in growth and the leaves were dark green and curled under at the edges. In fact, these were the poorest plots on the farm and their strong contrast to the adjacent plots made them easy to pick out by the many observers who passed judgment. The tobacco would have been hardly worth harvesting, even if the hail had not destroyed it.

Various explanations might be advanced for this result, but at any rate it is certain that under the dry conditions of this test on a sandy soil, the accumulated organic matter did not serve to retain the water, a property frequently ascribed to it, for the use of the crop. On the plants, the symptoms were those of drought rather than of nitrogen starvation.

Different results were obtained in an experiment with shade tobacco on the S. F. Holcomb farm in West Granby. Here a heavy application of cow manure was made to alternating bents in the shade tent. On the manured bents the tobacco became taller and had a more luxuriant growth. Growth in the other bents was below the average and unsatisfactory. This was a new field, the second year in tobacco, which had been used many years for general crops. The available phosphorus was relatively low in the soil, 26 pounds phosphorus to the acre. These conditions may account for the results. In this case the commercial fertilizer was reduced to 850 pounds an acre, instead of 2300, where the manure was applied.

Despite the unfavorable results which were obtained on the station farm during the past year, other results and the experience of many growers lead us to believe that the moderate use of manure to supplement the commercial fertilizer is a good practice

[1] Tob. Sta. Bull. 10, 62. Conn. Agr. Exp. Sta. Bull. 299, 192.

wherever manure is available on the farms. Its purchase from outside sources at the high prices now commonly asked, however, is economically questionable. The shade tobacco grower may possibly be able to compensate himself for the added cost, but not the stalk grower. Manure contains a supply of all the elements which the growing plant needs, both the major three and the rarer elements. It may therefore supply a need which may be overlooked in preparing a concentrated chemical mixture. In this respect it is similar to tobacco stems. Some growers use stems and manure on alternate years and this practice seems to be sound.

When manure is used, the quantity of plant food supplied in the commercial mixture may be reduced, but not pound for pound, that is, a pound of plant food in manure does not seem to be as effective as a pound of the same element in a commercial mixture. Just how far this reduction may be carried is a matter for each grower to determine for his own type of soil. Certainly it is not economical to disregard entirely, as some do, the plant food which is added in manure.

It is generally conceded that manure alone will not produce the best results.[1] On the other hand, it is true that many fine crops of tobacco are being produced annually with no manure. Manure may be frequently beneficial, but it is not essential to the production of good tobacco.

EFFECT OF MANURE ON SOIL ACIDITY

In order to determine what effect annual applications of manure may have on the reaction of the soil, samples from the manure plots and adjacent unmanured plots on the station farm were tested at three different times. The first of these was taken in

TABLE 13. EFFECT OF MANURE ON ACIDITY OF THE SOIL

	pH reaction on—					
	May 8, 1929		July 3, 1929		October 15, 1929	
Kind of manure	Manure	Check	Manure	Check	Manure	Check
Stable, 20 loads	5.60	5.27	5.00	4.75	5.57	5.27
Stable, 40 loads	5.85	5.33	5.24	4.90	5.64	5.53
Adco, 30 loads	5.59	5.25	5.15	4.63	5.77	5.24
	5.50	5.30	5.30	4.60	5.90	5.03

the spring before plowing the land, one during the growing season when the crop was about half grown, and the third in the late fall of the fourth year of the test, before application of manure for the next year.

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[1] This opinion has been confirmed recently by experiments in Pennsylvania. See Pa. Bull. 240, 1929. The same conclusion was expressed by Jenkins after his experiments in Poquonock more than 30 years ago. Report of Conn. Agr. Exp. Sta. for 1897, 250.

Results of the tests presented in Table 13 show that manure has invariably made the soil less acid. Since this is true for all the different times of the year, it is obvious that this is a permanent effect and not transitory. Since black rootrot is favored by an alkaline reaction of the soil, it is possible that this change in reaction may at least partly account for the greater prevalence of

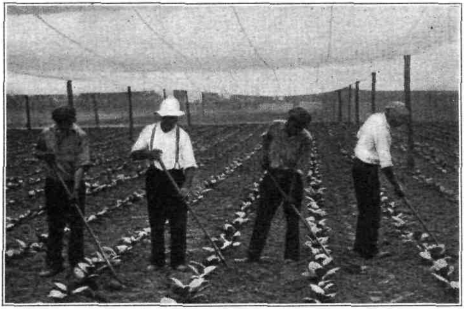


FIGURE 12. The second hoeing.

this disease in fields which have been heavily manured. The greater abundance of organic matter in the soil is probably also a contributing factor.

EFFECT OF MANURE ON THE BURN

Samples of the crop of 1928, taken from the center rows of each of the plots, were tested for fire holding capacity after sweating thoroughly and aging for a year. Results of these strip tests, presented in Table 14, indicate a slightly better burn for the manure plots. The differences, however, may be too small to be significant. Burn on all plots was so good that it is not easy to make any sharp distinction between tobacco grown with and without manure. At least we are safe in concluding that no impairment has resulted from the use of manure. These results agree rather closely with those of the Poquonock experiments of Jenkins, 1893-96. In three of the four years of that experiment, the fire holding capacity of the leaves from the manure plots was above the average of all the plots. In the fourth year it was somewhat below average (report for 1897, page 242).

In experiments in Ohio, Ames and Boltz (Ohio station Bulletin 285, 1915) also rated highly the buruing qualities of tobacco from

TABLE 14. MANURE SERIES OF 1928. STRIP BURN TESTS ON SWEATED SAMPLES

Carrier	Plot No.	Duration of burn (seconds) Darks	Mediums	Lights	Seconds	Average for Plot	Average for Treatment
Stable, 40 loads ..	M1	58	53	47	53	53	56
Stable, 20 loads ..	M1-1	59	59	59	57	58	
Adco, 30 loads ...	M2	59	57	55	60	58	58
	M2-1	58	54	59	59	58	
No manure	C3	58	54	54	57	56	53
	C3-1	58	57	49	50	54	
	C5	56	..	..	57	56	
	C5-1	51	52	54	53	53	
	C14	46	41	54	51	48	
	C14-1	44	50	51	55	50	

the manure plots. It has been found both in Connecticut and Ohio that tobacco from those plots contains an increased percentage of chlorine, but this does not seem to have affected adversely the fire holding capacity.

HYPER HUMUS

T. R. Swanback

Hyper Humus is a processed swamp peat residue, black and granular, consisting of decayed vegetation of past ages, which is marketed by the Hyper Humus Company of Newton, N. J. It is 80 per cent organic matter and has been used to advantage as a soil amendment for growing various crops which are benefited by increased organic matter in the soil. Since it seemed possible that tobacco also might be benefited by more organic matter in the sandy soils where it is commonly grown, some experiments with it have been made at this station. The results are here reported.

GREENHOUSE EXPERIMENTS

Greenhouse tests were made first in an attempt to determine *what quantity of Hyper Humus might be applied most profitably.* For this test, four-gallon crocks were filled with common sand and Hyper Humus in the following proportions, each treatment being in duplicate:

1. No Hyper Humus added
2. 12.5% " " by volume
3. 25% " " " "
4. 25% " " " "
5. 50% " " " "

The material was well mixed with the sand, together with 0.25 gm. $CaCO_3$ for each crock.

A nutrient solution was added to the crocks, except for number 3. It had the following composition:

Urea	30 cc of 1% solution
Sodium acid phosphate	24 cc " " "
Potassium carbonate	40 cc " " "
Magnesium sulphate	40 cc " " "
Traces of boron and iron.	

Enough water was added to obtain suitable moisture. One plant was set in each and allowed to grow for about 75 days before harvesting. Weight of the plants when harvested is given in Table 15.

TABLE 15. RELATIVE GREEN WEIGHTS OF TOBACCO PLANTS IN GREENHOUSE TESTS

Treatment and number	Green weight of 2 plants, ounces	Rel. weights of the total plant	Remarks
1. No Hyper Humus	3.88	1.00	
2. 12.5% " "	5.26	1.37	
3. 25% " "	4.88	1.26	No nutrients added
4. 25% " "	6.00	1.52	
5. 50% " "	8.38	2.16	

From this table it is evident that the 12.5 per cent treatment did nearly as well as the 25 per cent and was fully as good as treatment three, where no nutrients were added, but which also had 25 per cent Hyper Humus. The increased yield where Hyper Humus alone was added shows that the material either contains *some available plant nutrients or may have increased the* availability of those present. The benefit is more evident in the treatment with 50 per cent Hyper Humus, chemical treatment being the same as the check.

In a second test an attempt was made to determine the humus *requirements for optimum growth, by using quantities of the* material at closer intervals than in previous tests.

Pure silica sand, practically free from organic matter, was used in duplicate and percentages of Hyper Humus were 3, 6, 9, 12, 15, 18, 21, 24, 27 and 30 by volume. To each of the two-gallon crocks, *two liters of the following nutrient solution* was added.

Ammonium nitrate	0.200	gms.
Calcium nitrate	1.000	"
Di-potassium hydrogen phosphate	2.400	"
Magnesium sulfate	1.000	"
Ferric citrate	0.005	"
Traces of boron and manganese		
Water	1,000	"

One plant of Havana Seed tobacco was set in each crock. After a few weeks it was found that up to 21 per cent, each increase of Hyper Humus gave a corresponding increase in size of plants. They were harvested after two months. Dry weights at this time are given in Table 16.

From this experiment it appears that when pure silica sand is used, the quantity of Hyper Humus required for optimum growth lies around 21 per cent by volume, which would correspond to about 4.9 per cent of organic matter by weight.

Finally, a test was made to determine the ability of Hyper Humus to prevent or reduce leaching. Twelve two-gallon crocks were filled to a height of two inches with pure silica sand, on top of which was placed a two-inch layer of Hyper Humus. The crocks were then filled up with a mixture of common sand and station soil from a plot that had had no fertilizer treatment for a number of years, in the proportion of one to two.

Six crocks, for comparison, had a four-inch layer of silica sand at the bottom *without* a layer of Hyper Humus and were filled up with the sand-soil mixture. Nutrients were added in a dry form at the rate to the acre of:

200 lbs. nitrogen			455 lbs. potassium nitrate
160 " phosphoric acid		derived from	300 " urea
200 " potash			667 " sodium biphosphate

The nutrients were thoroughly mixed into the soil and then the crocks were watered. One plant of Havana Seed tobacco was set

in each crock. The plants developed about equally well in the two series. When they reached the budding stage, they were cut down in order to prevent the roots from penetrating the bottom layer

TABLE 16. DRY WEIGHTS OF TOBACCO PLANTS GROWN IN PURE SAND + VARYING QUANTITIES OF HYPER HUMUS

Per cent Hyper Humus by volume	Approximate per cent of Hyper Humus by weights	Ounces: Whole plant, average of 2 plants	Ounces: Leaves: Leaves	Ounces: Leaves: Average of 2 plants
0	0.0	1.35	0.45 0.40	0.43
3	0.7	2.50	0.50 0.60	0.55
6	1.4	3.30	0.70 0.55	0.63
9	2.1	3.25	0.55 0.75	0.65
12	2.8	3.25	0.70 0.75	0.73
15	3.5	3.45	0.70 0.80	0.75
18	4.2	3.00	0.70 0.75	0.73
21	4.9	4.20	0.80 0.85	0.83
24	5.6	4.20	0.75 0.80	0.80
27	6.3	3.85	0.85 0.75	0.80
30	7.0	3.80	0.80 0.85	0.83

of silica sand, which was not to be depleted in nutrients through absorption by the plants. Soil and Hyper Humus were removed from the crocks and the remaining silica sand was well mixed, so as to obtain composite samples from the twelve humus treated pots, as well as from the checks. On these samples, Mr. Jacobson of the soils department determined the content of nitrogen, phosphorus and potash.

The results are given below:

	Per cent N	ppm NO_3	ppm P	ppm K
Check (no Hyper Humus)	.0139	21.7	15	44.22
Hyper Humus treated	.0187	20.8	15	41.41

It should be kept in mind that the volume of silica sand in the check pots was twice as large as that of the treatment. On this account the figures for the treatment would be cut approximately in half. The results of this test would thus indicate that Hyper Humus to an extent of 50 per cent decreases leaching of nutrients.

In another experiment, the quantity of silica sand at the bottom was equal for all treatments. Into two of them was placed a two-inch layer of Hyper Humus alone, two other crocks had a six-inch

layer of soil added and the third pair had a layer of humus and a layer of soil on top of the silica sand. An equal portion of a nitrate of soda solution was poured on the crocks containing soil. Thereafter equal amounts of water were poured on all the crocks, a procedure which was repeated a few times. Samples from the silica sand were taken, as in previous experiment, and content of nitrates was determined. The results are listed below:

	Crock 1	Crock 2
Hyper Humus alone	37.2 ppm	20.4 ppm
Soil alone	1136 "	1107 "
Hyper Humus + soil	673 "	569 "

If the amount of nitrate present in the humus be subtracted from the nitrate content of the humus + soil treatment, it is apparent that the Hyper Humus was able to check about fifty per cent of the leaching, which is in agreement with the conclusion reached above.

FIELD EXPERIMENTS

In 1927, plots of one-eightieth of an acre were laid out in two series, Series I on Field VII and Series II on Field VI, each including four different quantities of Hyper Humus applied to the soil, 10, 20, 30 and 40 tons to the acre. The material was spread on the plots in April and thoroughly harrowed into the soil, which also received commercial fertilizer, equally for all plots, at a rate of 250 pounds ammonia, 100 pounds phosphoric acid and 200 pounds potash to the acre. Plants on all were set early in June. During the growing season the growth in general was better on the treated plots than on plots not treated with Hyper Humus.

The tobacco was harvested early in August. Curing of the crops was very good for Series I, while some of the tobacco was damaged in the curing of the second series. Table 17 gives the sorting records for the Hyper Humus experiment of 1927.

TABLE 17. HYPER HUMUS PLOTS. SORTING RECORD FOR 1927 CROP

	Tons Hyper Humus to acre	Yield of leaves, lbs. to acre	Percentage of grades L	M	LS	SS	LD	DS	F	B	Grade index
Series I	None	1062	7	5	14	10	31	6	16	11	.346
" "	10	1197	16	8	19	7	30	1	10	9	.454
" "	20	1121	10	6	21	6	31	4	12	10	.403
" "	30	1145	19	9	15	6	31	1	13	6	.466
" "	40	1227	16	7	21	7	30	2	11	6	.460
Series II	None	1296	9	8	15	5	47	3	11	2	.403
" "	10	1387	5	4	20	4	36	7	14	10	.352
" "	20	1296	4	6	15	7	33	14	15	6	.335
" "	20	1397	7	4	19	5	40	2	14	9	.370
" "	30	1441	8	7	15	4	43	2	13	8	.378
" "	40	1208		4	14	7	32	10	16	17	.284

The tobacco in Series I was all rated as of good quality. Yield figures and grade indexes indicate that there were no appreciable differences in results between the varying quantities of Hyper Humus, although in general the treatments all show better results than the check plots. From the results above the following summary is made:

Average yields without Hyper Humus ..	1179 lbs. to acre
" " with Hyper Humus	1269 " " "
" grade without Hyper Humus..	.375
" " with Hyper Humus	.389

The tests were continued in 1928. In the fall of 1927 the treated plots received the same amounts of Hyper Humus as were applied in the spring of the same year. Although the crop in the field looked rather promising, the sorting records of the cured tobacco have a very poor showing, as may be learned from Table 18.

TABLE 18. SORTING RECORDS OF HYPER HUMUS. CROP OF 1928

	Total Hyper Humus to acre	Acre yield Plot	Acre yield Ave.	L	M	LS	SS	LD	DS	F	Grade index Plot	Grade index Ave.
Series I	None	880		1	..	14	20	18	25	22	.280	
" "	10	986		..	..	..	33	32	14	21	.244	
" "	20	908					34	27	15	24	.237	
" "	30[1]											
" "	40	1080		4		13	27	24	17	15	.320	
Series II	None	1305	1199	4	9	33	10	27	5	12	.425	.350
" "	None	1093		7	4	20	13	33	8	15	.275	
" "	10	926				23	16	20	17	24	.302	
" "	20	1051	1036	3		15	22	28	11	21	.313	.347
" "	20	1020		3	5	29	7	31	7	18	.380	
" "	30	1312				24	9	42	11	14	.333	
" "	40	1175		3	2	13	26	24	15	17	.317	

Neither the yields nor the grade indexes, with two exceptions, were improved by the treatments. A summary of the results will plainly show the slight differences:

Average yield without Hyper Humus	1039 lbs. to acre
" " with Hyper Humus	1049 " " "
" grade index without Hyper Humus ..	.315
" " " with Hyper Humus	.312

It may be mentioned that adjacent to the Hyper Humus plots in Series I was a manure plot which yielded 1069 pounds to the acre with a grade index of .319. Comparing this result with the best result in Series I, it is apparent that this treatment, now amounting to 80 tons of Hyper Humus to the acre, gave results similar to the same application of manure. This raises the question whether Hyper Humus will stand in competition with manure, economically or otherwise, in field culture of tobacco.

[1] Excluded because of error in stripping.

BURN TESTS

Burn tests were made on sweated samples of tobacco from the Hyper Humus series of the 1928 crop. The technique of these is described in previous bulletins of this station.

The results, recorded in Table 19, show that Hyper Humus in most cases had lowered the fire holding capacity, as judged by the strip test. A possible explanation to this may be the fact that Hyper Humus, contrary to ordinary peat, contains considerable lime, since it is produced from an old lake basin with *calcareous sedimentation.*

TABLE 19. HYPER HUMUS SERIES FOR 1928. STRIP BURN TEST ON SWEATED SAMPLES

Tons Hyper Humus to acre	Duration of burn (seconds) Darks	Mediums	Lights	Seconds	Average
None	58	54	54	57	56
20	43			53	48
40	53			59	56
60	57			54	56
80	55		50	42	49
None	56	45	60	58	55
None	56	56	52	54	55
20	29			32	31
40		33	34		34
40	25		18	30	24
60	58			52	55
80	48	22	23	22	29

SUMMARY OF SERIES I AND II

20 tons of Hyper Humus	40 sec.
40 " " " "	43 "
60 " " " "	56 "
80 " " " "	39 "
Average of checks (no Hyper Humus)	56 "
" " Hyper Humus treatments	45 "

SEED BED EXPERIMENTS

Inquiry from several growers on the use of Hyper Humus for tobacco seed beds led us to undertake a test with this material on two of the station seed beds, each measuring about three and one-third square rods or 880 square feet.

In October, 1928, one ton of Hyper Humus was harrowed into each of the beds. For comparison, a third received about one ton of well decomposed horse manure. Each bed received one bag of castor pomace which was harrowed in together with the humus and the manure. The following spring it was observed that *the growth* of tobacco plants was equally good in the two treatments. Also the *soil temperature* remained the same in both.

In *pulling the plants,* it was noticed that fully as big a lump of soil stuck to the roots from humus treated beds as from the

manured one. One year's result would probably not justify any recommendations but the test seems to permit the use of Hyper Humus as a substitute for manure in seed beds, especially where the latter is not readily available.

DISCUSSION OF RESULTS

It is evident from the greenhouse experiments that addition of Hyper Humus up to a certain extent has benefited the growth of tobacco, while in the field tests the results are only slightly in favor of the material. An important difference in the experiments

FIGURE 13. Application of poison bait for killing cut worms.

is that in the greenhouse tests the humus was added to sand practically free from organic matter, while in the field the treatments were merely an addition to the organic matter already present. Ordinarily the tobacco soils in the Connecticut Valley contain from three to five per cent organic matter[1] and increasing the content in the fields where it is lower than this would probably be beneficial. Appleman,[2] investigating the effect of organic matter on soils, found that an early crop of potatoes came up sooner than did the potatoes in the control rows. This investigator also noted that the content of CO_2 increased in the treated rows up to 0.24 per cent, as compared with 0.058 per cent in the

[1] Conn. Tob. Substation Bull. 10, 66-71, 1927.
[2] C. O. Appleman: Percentage of Carbon Dioxide in Soil Air, Soil Science, 1927, XXIV, 241-245.

non-treated ones. The carbonic acid present in the soil would probably serve as a solvent for less available nutrients.

In order to observe to what extent organic matter had increased in the humus-treated plots, samples were taken six months after the second application from the various treatments, as well as from the checks. The content of organic matter was determined by Mr. Jacobson of the soils department. Results are given below:

Average content of organic matter from check plots	3.45%
" " " " " " application of 20 ton H-H	3.67%
" " " " " " " " 40 " "	4.10%
" " " " " " " " 60 " "	4.63%
" " " " " " " " 80 " "	4.63%

Up to 60 tons to the acre there was a steady increase in organic matter, while further applications did not increase the content correspondingly.

In general, the addition of Hyper Humus has caused little improvement in yield. Carbonaceous material, that is, not fully decomposed plant residues, present in a soil requires for its decomposition a certain amount of nitrogen. Investigators[3] have found a distinct relation between the carbon and nitrogen contents of soils. That is, the carbon-nitrogen ratio will remain constant. Therefore, where Hyper Humus is used as a soil amendment, care should be taken to supply sufficient nitrogen to permit the biological changes in the soil, as well as the nutrition of the plants grown thereon.

Finally, it should be mentioned that the soil reaction had not changed through the addition of the various quantities of humus. Determinations were made in July, 1929, with the following results:

Checks (No H-H)	4.90 pH
20 tons H-H	4.90 "
40 " "	4.93 "
60 " "	4.85 "
80 " "	4.83 "

[3] Sievers, F. J., and Holtz, H. F. The Significance of Nitrogen in Soil Organic Matter Relationships. Wash. Agr. Exp. Sta. Bull. 206, 1926.

CHEMICAL COMPOSITION OF A POOR BURNING TOBACCO CROP COMPARED WITH A GOOD BURNING CROP

E. M. Bailey and P. J. Anderson

It is well known to leaf dealers and manufacturers that crops of certain years do not burn well, while those of other years are distinguished by their excellent burning qualities. This difference has also been observed in the burn tests which have been made on the crops of the different years at the experiment station. The crop of 1924 had an extremely low fire holding capacity, coaled badly on the cigar and had a bitter taste. The crop of 1927, in contrast, had an unusually long fire holding capacity and good burning qualities on the cigar. In our report for 1928, it was pointed out that the fire holding capacity of our crops has shown a general correlation with the rainfall of the season during which they were grown. Thus the poor burning crop of 1924 was grown in an extremely dry season and the good burning crop of 1927 during a season of high rainfall. This same correlation between rainfall and burn has been observed in Pennsylvania by Haley, Nassett and Olson.[1]

There are two ways in which a season might affect the leaf; it might change its chemical composition, or it might change the mechanical structure of the leaf. In order to see how the season affects the chemical composition, tobacco from the two contrasting crops of 1924 and 1927 was analyzed by the analytical chemistry department. Samples were taken from plots which had the same fertilizer treatment for the two years, as well as during the intervening years. This included six plots of the old potash series and six plots from the lime series. Two grades, darks, D, and seconds, S, were selected for analyses. Some of the samples from the 1924 crop were not available because they had been used up in previous tests.

Results of the analyses are presented in Table 20.

This table shows that there were considerable and consistent differences in content of potash, chlorine, nitrogen and calcium and smaller differences in magnesium and phosphorus.

Potash. During the wet year the potash content was consistently higher, in the old potash series, than during the dry year. In the lime series, however, the potash content had been greatly reduced by yearly applications of lime. Morgan, Anderson and Dorsey[2] have shown that this reduction in potash content con-

[1] Plant Physiology, 1928, III, 185-197.
[2] Conn. Agr. Exp. Sta. Bull. 306, 1929.

sistently follows application of lime and also on these same plots the fire holding capacity was correspondingly reduced. Haley, Nassett and Olson found that the potash content of tobacco leaves is higher during seasons of heavy rainfall. In view of the well known influence of potash in promoting burn, it seems likely that this was a contributing factor in making the 1927 crop burn better than the 1924 crop.

Chlorine. In the dry year crop of 1924, the chlorine content of the leaves was from two to ten times as great as in the 1927 crop. Perhaps no one element is more deleterious to burn than chlorine. It is therefore probable that this was a second contributing factor to the poor burn of the 1924 crop. Since chlorine salts are very readily leached from the soil, it is to be expected that during the wet year, any chlorine which was in the fertilizer would be quickly carried away, while during the dry year the chlorine salts would be absorbed by the roots of the plants.

Calcium. This element was consistently higher in the 1924 crop. According to the explanation offered by Haley, Nassett and Olson, calcium in the soil complex is replaced by potassium when potash salts are applied in fertilizer. This results in the accumulation of calcium salts in the surface soil. Heavy rains leach them down, but in a dry season they remain and are absorbed by the tobacco roots, which results in a more abundant deposit of calcium salts in the leaves.

In previous articles we have presented abundant data to show the retarding influence of lime on the fire holding capacity of tobacco as measured by the strip test. This apparently has been due to magnesium rather than calcium. Calcium salts are not known to improve the fire holding capacity, but on the other hand, there is little conclusive evidence that they hinder it.

Magnesium. Only the plots K1, K1-1, K3, T1b and T2b give us a true comparison of the magnesia content in dry and wet years. These show that more magnesia was deposited in the leaves in a dry year. The explanation of this is probably the same as for calcium. *Plots K2 and K2-1 received annual applications of sul-*fate of potash magnesia and the high magnesia content of the later year may be due to accumulation of that element through the intervening years. Plots T1a and T2a and T3a received yearly application of magnesia in limestone and as a result the 1927 crop showed the highest percentage of magnesia of any of the samples tested. Comparison of these figures with the K2, K2-1 figures for the same year shows that dolomitic limestone is more effective than double manure salts in introducing magnesia into the leaves wherever such a result is desired.

In previous reports we have shown that magnesia has a decided influence in reducing the fire holding capacity of tobacco. Garner also finds that all magnesium salts are injurious to burn. Like the calcium salts, however, they make the ash white.

The greater abundance of magnesium in the leaf during a dry year is probably another contributing factor to poor burn.

Nitrogen. The most striking contrast shown by the analyses is in the nitrogen content. In every comparison without exception nitrogen is higher in the tobacco of the dry year. This applies not only to total nitrogen but also to every form of nitrogen. All the forms of nitrogen, with the exception of nitrates, are considered injurious to burn of tobacco. Any beneficial influence of the small amount of nitrate was probably more than counterbalanced by the quantity of the other nitrogenous compounds. The higher nicotine content may account for the bitter taste of the 1924 crop and the greater abundance of albuminous compounds for its poor aroma. The high nitrogen content of the leaf in a dry year is probably due to accumulation of nitrates in the surface soil—without leaching—and to retarded growth which prevents proper dilution in the plant.

Phosphorus. Phosphoric acid content was consistently higher in the dry year. The explanation is not obvious. Phosphates are injurious to fire holding capacity.

Sulfur. Total sulfur was also somewhat higher in the dry year. The apparent exceptions shown in the tobacco from plots K2 and K2-1 are due to the larger quantity of sulfur supplied yearly to these plots in double manure salts. The same differences in sulfur content were shown in the crop of 1926[1] on these plots. The injurious effect of sulfur on burn is discussed in another section of this report.

Manganese was consistently higher in the dry year. The apparent exceptions in plot T1b are due to the heavy annual applications of sulfate of ammonia to this plot. This made the soil more acid. It has been shown in previous reports of this station that a more acid soil results in increased manganese in the leaf. This same fact probably explains the increase of manganese during the dry year of 1924 in the other plots, that is, the soil is naturally more acid during a dry year. No data are available on the effect of increased manganese on the burn.

Silica, iron and alumina were all consistently more abundant in the leaves in the wet year. All three are probably inert as far as burn is concerned.

ALKALINITY OF THE WATER SOLUBLE ASH[2]

As long ago as 1870, Schloesing[3] showed that there is in general a direct relation between the alkalinity of the water soluble constituents of a tobacco ash and its fire holding capacity. Alkalinity

[1] Conn. Agr. Exp. Sta. Bull. 299, 157.

[2] Determined according to Methods of Analysis, Asso. Off. Agr. Chemists. Edition 1925, page 180, sections 9, 12 and 13. Two grams of material used.

[3] Schloesing, Th. Uber die Verbrennlichkeit des Tobaks. Journ. F. prak chemie, LXXXI, 143-150.

Grade	Treatment		Total ash 1924	Total ash 1927	SiO_2 1924	SiO_2 1927	$Fe_2O_3 + Al_2O_3$ 1924	$Fe_2O_3 + Al_2O_3$ 1927	CaO 1924	CaO 1927	MgO 1924	MgO 1927	Mn_3O_4 1924	Mn_3O_4 1927	K_2O 1924	K_2O 1927	P_2O_5 1924	P_2O_5 1927
	Potash Series																	
D	All K in H. G. sulfate		26.18	25.33	2.45	3.65	0.42	0.43	5.16	4.47	1.35	0.58	0.16	0.10	8.08	8.00	1.01	0.78
S				31.40		5.50		0.76		5.59		0.75		0.15		9.26		0.72
D	All K in double manure salts		25.76	25.84	2.46	3.84	0.33	0.49	4.86	3.88	1.44	1.22	0.16	0.12	7.80	8.43	0.99	0.76
S			28.23	30.84	3.36	6.63	0.40	0.89	5.63	4.42	1.63	1.71	0.16	0.16	7.97	8.84	0.87	0.65
D	Half and half		26.46	26.41	3.02	4.51	0.31	0.45	5.03	4.17	1.36	0.99	0.11	0.09	7.93	8.00	0.92	0.84
S				31.58		7.85		0.88		4.96		1.20		0.13		8.39		0.68
D	All K in H. G. sulfate		26.41	24.97	2.86	3.53	0.38	0.35	5.17	4.08	1.36	1.04	0.16	0.06	7.88	8.31	1.05	0.79
S				32.26		8.07		0.87		4.91		0.87		0.13		8.81		0.64
D	All K in double manure salts		25.68	26.73	2.76	4.28	0.37	0.47	4.98	3.99	1.31	1.81	0.13	0.12	7.48	8.24	0.92	0.74
S			28.87	32.33	3.90	8.37	0.39	0.98	5.91	4.55	1.60	1.62	0.14	0.11	7.83	8.33	0.76	0.60
D	Half and half			25.39		3.77		0.38		4.23		1.09		0.05		7.89		0.76
S				30.66		7.40		0.73		5.23		1.43		0.08		7.59		0.54
	Lime Series																	
D	Acid fertilizer	With lime	25.78	23.81	2.27	5.48	0.24	0.48	6.17	4.30	1.12	2.93	0.08	tr.	6.81	4.66	0.97	0.60
S				28.17		9.12		0.83		4.65		3.91		tr.		3.89		0.58
D		Without lime	26.01	25.08	3.72	3.84	0.38	0.39	4.53	4.96	1.15	0.76	0.15	0.24	7.66	7.04	1.02	0.77
S			28.15	29.67	3.89	7.16	0.40	0.81	6.15	5.73	1.21	0.78	0.13	0.34	7.08	7.01	0.96	0.71
D	Alkaline fertilizer	With lime	25.46	22.85	2.65	3.90	0.22	0.24	5.87	4.21	1.08	2.35	0.02	0.00	6.82	5.51	0.89	0.61
S				28.05		7.12		0.41		4.91		2.73		0.00		5.62		0.48
D		Without lime	25.29	24.28	2.52	3.66	0.33	0.52	5.77	4.76	1.06	0.70	0.04	0.02	6.90	7.11	0.96	0.68
S				30.60		8.62		0.96		4.96		0.66		0.02		7.32		0.58
D	Neutral fertilizer	With lime		22.01		3.17		0.18		4.19		3.21		tr.		5.03		0.53
S			29.39	25.73	3.99	6.60	0.38	0.41	7.87	4.49	1.33	4.23	0.02	0.00	5.99	4.24	0.62	0.42
D		Without lime		23.57		3.23		0.31		4.57		0.94		0.02		6.88		0.67
S				30.26		8.97		1.02		5.62		1.22		0.03		5.96		0.40

... CROP OF 1924 (POOR BURN) COMPARED WITH CROP OF 1927 (GOOD BURN), MOISTURE FREE BASIS (Continued)

Plot	Grade	Treatment		Cl 1924	Cl 1927	S (total) 1924	S (total) 1927	N (total) 1924	N (total) 1927	N (as NH_3) 1924	N (as NH_3) 1927	N (as NO_3) 1924	N (as NO_3) 1927	N in (nicotine) 1924	N in (nicotine) 1927	Nicotine 1924	Nicotine 1927	Alkalinity of water soluble ash 1924	Alkalinity of water soluble ash 1927
		Potash Series																	
K1	D	All K in H. G. sulfate		0.61	0.43	0.86	0.73	4.79	4.00	0.47	0.24	0.62	0.37	0.37	0.29	2.17	1.69	94.8	108.0
K1	S				0.37		0.76		3.09		0.06		0.62		0.15		0.86		129.8
K2	D	All K in double manure salts		0.54	0.27	0.93	0.86	4.64	3.82	0.45	0.19	0.36	0.13	0.39	0.29	2.23	1.69	91.0	109.0
K2	S			0.50	0.18	0.79	0.83	5.10	3.05	0.34	0.13	0.62	0.52	0.38	0.17	2.19	0.97	100.0	124.5
K3	D	Half and half		0.59	0.21	0.82	0.79	4.65	3.67	0.43	0.15	0.39	0.17	0.41	0.20	2.40	1.17	90.5	111.0
K3	S				0.15		0.73		2.70		0.08		0.39		0.12		0.67		125.4
K1-1	D	All K in H. G. sulfate		0.65	0.26	0.83	0.76	4.70	3.75	0.52	0.24	0.84	0.17	0.43	0.36	2.46	2.09	91.0	114.3
K1-1	S				0.15		0.68		2.45		0.09		0.21		0.17		0.98		137.0
K2-1	D	All K in double manure salts		0.53	0.27	0.89	0.96	4.55	3.47	0.45	0.19	0.52	0.35	0.45	0.27	2.58	1.54	89.5	105.5
K2-1	S			0.44	0.14	0.74	0.82	3.76	2.44	0.31	0.13	0.77	0.30	0.35	0.16	2.00	0.91	102.0	115.5
K3-1	D	Half and half			0.25		0.79		3.73		0.30		0.26		0.38		2.20		108.5
K3-1	S				0.15		0.59		2.37		0.13		0.22		0.20		1.18		116.5
		Lime Series																	
T1a	D	Acid fertilizer	With lime	0.48	0.04	0.74	0.58	5.10	2.67	0.56	0.25	0.52	0.00	0.48	0.41	2.80	2.37		
T1a	S				0.04		0.55		2.18		0.21		0.00		0.35		2.02		
T1b	D		Without lime	0.51	0.09	1.03	0.78	5.37	3.74	0.63	0.27	0.83	0.26	0.40	0.36	2.34	2.06		
T1b	S			0.41	0.04	0.79	0.69	4.47	2.80	0.45	0.15	0.75	0.13	0.39	0.23	2.24	1.34		
T2a	D	Alkaline fertilizer	With lime	0.50	0.04	0.51	0.45	4.78	2.76	0.49	0.24	0.64	0.00	0.45	0.35	2.62	2.00		
T2a	S				0.09		0.45		2.08		0.09		0.00		0.23		1.34		
T2b	D		Without lime	0.47	0.28	0.54	0.47	4.89	3.38	0.52	0.26	0.62	0.09	0.49	0.39	2.82	2.27		
T2b	S				0.42		0.42		2.36		0.13		0.13		0.25		1.47		
T3a	D	Neutral fertilizer	With lime		0.04		0.37		2.83		0.28		0.04		0.43		2.46		
T3a	S			0.47	0.22	0.42	0.34	3.81	1.97	0.30	0.22	0.86	0.00	0.47	0.35	2.71	2.03		
T3b	D		Without lime		0.04		0.53		3.34		0.26		0.09		0.39		2.24		
T3b	S				0.04		0.39		2.09		0.17		0.00		[illegible]		[illegible]		

of the ash solution is due almost entirely to the carbonate of potash which it contains; that is, the more carbonate, the more alkaline the solution. The leaf does not contain carbonate of potash, but when it is burned, potash salts of the organic acids, malate, citrate, and others in the leaf, are oxidized to carbonate. The inorganic potash salts, sulfate, chloride and phosphate, are not changed. Hence the alkalinity of the ash solution is a measure of the quantity of organic potash salts which the leaf contains, and, as has been frequently pointed out, the more organic potash salts, the better the burn.

In the good burning crop of 1927, the increased percentage of potash and reduced percentage of sulfate, chlorine and phosphate would indicate that more of the potash was combined with the organic acids than in the poor burning crop of 1924. In order to see whether this relationship is further indicated by the alkalinity of the water soluble ash, and to determine the parallelism between this factor and the fire holding capacity of the leaf, the analyses recorded in the last two columns of Table 20 were made.

These figures show that in every case the results are as would be anticipated; that is, the alkalinity of the good burning 1927 crop is uniformly much higher than that of the poor burning crop of 1924. Also it is of interest to note that the alkalinity of the seconds, usually the best burning leaves, is in every case higher than that of the darks from the same plot.

Alkalinity of the soluble ash thus appears in this comparison to be a good index to fire holding capacity.

CHEMICAL INVESTIGATIONS OF TOBACCO[1]

By Hubert Bradford Vickery and George W. Pucher

In spite of the great economic importance of the tobacco plant, there is not available sufficient accurate information on the nature of the various chemical compounds that are present in the green leaf or the changes which they undergo during the curing and fermentation processes. The identification of these compounds and a study of the reactions by which they are formed and in which they play a part is of fundamental importance for the understanding of the metabolism of the plant and may lead to improved methods for the production and use of the tobacco plant.

Although a plant tissue contains a complex mixture of substances, it is possible to classify these substances into groups the members of which have certain common characteristics. For practical reasons we have selected as our first point of attack the large and complex group of compounds that contain nitrogen.

The nitrogenous compounds of the tobacco plant may be divided, as a matter of convenience, into those that are soluble in hot water and those that are insoluble. It is this first group of compounds upon which our experimental work is being concentrated at the present time. This fraction contains volatile and non-volatile bases, nitrates, amides and amino acids, purines, and probably many other substances of less well-known types. As a first step in the elaborate series of operations that must be carried out before any single substance can be isolated and identified, accurate methods of chemical analysis must be developed so that the various details of the manipulations may be followed quantitatively. The analysis of tobacco extracts presents such unusual difficulties that new or considerably modified methods, even for the determination of the most commonly occurring nitrogenous substances, must be devised.

The presence of nicotine, a base almost as volatile as ammonia, in tobacco extracts has made it necessary to develop a special technique for the determination of ammonia nitrogen and of amide nitrogen. The methods hitherto used are elaborate and tedious, involving uncertain corrections for the nicotine present. Our method takes advantage of a curious property of permutit, a synthetic silicate, which, at the proper reaction, undergoes selective

[1] The chemical investigations of tobacco herein described were carried out as part of a general project under the title "Cell Chemistry," by the Department of Biochemistry of the Connecticut Agricultural Experiment Station, New Haven, Conn. The Department has enjoyed the benefit of close coöperation from the Tobacco Substation. The expenses were shared by the Connecticut Agricultural Experiment Station and the Carnegie Institution of Washington, D. C.

quantitative base exchange with ammonia in the presence of other volatile bases such as nicotine and trimethylamine, thereby removing the ammonia from the solution. The ammonia so taken up may be quantitatively released by adjusting the reaction and then estimated colorimetrically by Nessler's solution. The figures thus obtained represent the actual ammonia content of the extracts analyzed and corrections for nicotine or other amines are not required. The presence of nicotine and ammonia has also made it advisable to develop a modification of the Jones method for the determination of nitrates that are usually present in the extract. This modification enables us to determine the nitrate content of tobacco with considerable accuracy.

The presence of nitrates in tobacco plant extracts makes it necessary to employ special methods for the determination of total nitrogen in them. We have confirmed the observations of Ranker (1)[1] that the well-known and widely used salicylic acid-zinc method, when applied to aqueous extracts, gives inaccurate results and this observation has compelled us to develop a method that can be applied to aqueous solutions. The results of this investigation are being prepared for publication at the present time.

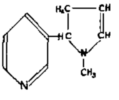
It may also be mentioned here that evidence has been accumulated which indicates that the determination of peptide nitrogen by the methods generally used may be erroneous when tobacco samples containing large quantities of nitrates are analyzed.

Each method of analysis must be studied in detail in order to ascertain whether the data obtained have significant value when the method is applied to tobacco extracts.

THE BASES OF TOBACCO EXTRACTS.

a. NICOTINE.

Nicotine is the chief volatile alkaloid of the tobacco plant.



Structure formula of nicotine.

This substance has received a great deal of attention from tobacco investigators. Nevertheless, in spite of a vast accumulation of data, there is still no real explanation of the source of nicotine in the plant nor more than speculation concerning its function.

[1] Numbers in parentheses refer to bibliography on page 245.

The amount of nicotine present in the tobacco leaf varies over a wide range depending upon the age, species and method of cultivation. The relationship between the age of the plant and its content of nicotine is extremely interesting. Thus it has been shown by Smirnov (2) that nicotine constantly increases during the life period of the plant. This investigator believes that nicotine represents a passive substance in the metabolism and that the quantity present may serve as an index of the age of the plant.

Pictet (3, 4) has suggested that nicotine may be formed during the growth of the plant from decomposition of the complex nitrogenous constituents, such as protein, nucleic acids, chlorophyll, etc., in the tissues. Mothes (5), however, has taken exception to this view and advanced experimental evidence to show that nicotine is not derived from the breakdown of protein. This investigator concluded that: 1. Nicotine is not a reserve material for nitrogen metabolism. 2. Nicotine synthesis takes place where there is active growth and is influenced neither by light nor by the introduction of outside sources of nitrogen. 3. The quantity of nicotine synthesized is not proportional to the size of the leaves. 4. There is no relationship between the amount of protein and the amount of nicotine synthesized.

Garner (6) has suggested that nicotine is present in the tobacco leaf in two forms, the one combined with organic acids of the leaf and the other free, or very loosely combined. The "free" nicotine has been correlated with the flavor of tobacco, a high proportion being, in part at least, responsible for the harsh and disagreeable taste sometimes observed. In view of this the determination of the proportion of "free" nicotine may be of importance in judging the quality of tobacco.

Nicotine is an organic base and can combine with one or with two equivalents of acid. The extent to which combination takes place varies with the hydrogen ion concentration of the solution. The hydrogen ion concentration of an extract of tobacco depends upon the relative proportions of the soluble basic and acidic substances derived from the leaf: the extent of hydrolysis of the salts of nicotine contained in such an extract will determine the fraction of the total nicotine which is present as "free" nicotine. The well-known equation

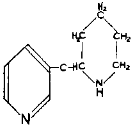
$$\mathrm{pH} = \mathrm{pK} + \log \frac{[\text{free base}]}{[\text{salt of base}]}$$

shows that the degree of hydrolysis, represented by the last term, depends only on the reaction of the solution and the dissociation constant of the base. Once the magnitude of the dissociation constant of nicotine has been determined, a curve can be constructed from which the proportion of the nicotine present in the "free" form in a sample of tobacco can be read directly at the point corresponding to the hydrogen ion concentration of an aqueous

extract of the sample. The dissociation constants of nicotine have therefore been determined (7) and a curve showing the relation between the degree of hydrolysis and the hydrogen ion concentration has been constructed. This curve permits an accurate and simple evaluation of the "free" nicotine of tobacco samples, since a determination of the hydrogen ion concentration only is required. This is most conveniently accomplished by the quinhydrone electrode.

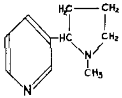
b. ALKALOIDS OTHER THAN NICOTINE IN TOBACCO EXTRACTS.

Pictet and Rotschy (8) first demonstrated that there are a number of bases that possess properties allied to those of nicotine present in tobacco extracts. Of these, nicotimine, a liquid isomeric with nicotine, is volatile with steam. The formula proposed by Pictet and Rotschy represents this substance as 2-piperidyl-3 pyridine. The correctness of this formula was not, however, conclusively proved.



Nicotimine.

Two other bases isolated by Pictet and Rotschy were not volatile with steam. Nicoteine, a liquid, was assigned a formula

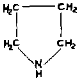


Nicoteine.

which represents a reduced form of nicotine. Nicotelline was isolated as a crystalline solid. No structure has been assigned to it.

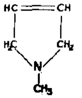
Noga (9) some years ago described two substances isolated from tobacco as new alkaloids to which he gave the names isonicoteine and nicotoine. The experimental evidence for the existence of these substances is not entirely convincing.

In addition to the alkaloids that have been mentioned, Pictet and Court (4) isolated from cured tobacco small amounts of the simple nitrogenous bases, pyrrolidine,



Pyrrolidine.

and N-methyl pyrroline.



N-methyl Pyrroline

These substances were considered by Pictet as probable precursors of nicotine and the related alkaloids of the tobacco plant.

The alkaloids and simpler bases of tobacco are of great interest to the plant physiologist. No exhaustive investigation of the metabolic changes in the plant which give rise to their formation has ever been published, although the problem is of much importance.

It is clear from this discussion of the work of Pictet that a steam distillate obtained from an alkaline extract of tobacco may contain other substances in addition to nicotine. One, at least, of these substances is an alkaloid that behaves in a manner similar to nicotine, that is, it forms an insoluble silicotungstate and picrate and is difficult to separate from this substance. It is evident, therefore, that existing methods for the determination of nicotine in tobacco are not exact, since the silicotungstate precipitate prepared in the usual way inevitably contains any other volatile alkaloid similar in structure to nicotine. The "nicotine" determination on the steam distillate of a tobacco sample therefore gives values that represent the sum of the nicotine and the other volatile base or bases that are precipitated by silicotungstic acid. Inasmuch as the other volatile bases make up only a small part of the whole, the complexity of the precipitate is not of great significance in practical work, but this fact must be recognized in any detailed study of the chemistry of the tobacco plant.

A rough idea of the amount of the substances other than nicotine that are precipitated by silicotungstic acid from the steam volatile fraction of extracts of cured tobacco leaves was secured from the following data. A steam distillate that contained 63.0 gm. of

nicotine as determined by silicotungstic acid precipitation was subjected to a careful examination by fractional crystallization of the picrates of the alkaloids. The equivalent of 58.0 gm. of nicotine was obtained as picrate and 4.1 gm. of other alkaloids, likewise as picrates, were found. Thus at least 6.5 per cent of the "nicotine" indicated by the silicotungstic acid method actually represents volatile bases other than nicotine. These are minimum values since losses occurred in the manipulations.

From the bases other than nicotine, 0.6 gm. of a base was isolated that reacted with nitrous acid and with benzoyl chloride in the manner described by Pictet and Rotschy for nicotimine. This material gave a beautifully crystalline dipicrate much more soluble than nicotine dipicrate and quite different from it in appearance. The decomposition point was 179.5-180.5° C. (uncorr.), whereas nicotine dipicrate decomposes at 218-220° C. (uncorr.). Pictet described his preparation as an oily picrate that melted at 163°C. Our preparation, perhaps due to its greater degree of purity, had a higher melting point. In the crude form it yielded an oily picrate with a melting point around 170-175°C. The nitrogen content of the pure picrate was 18.29 per cent, while the nitrogen calculated for nicotine dipicrate was 18.06 per cent. The substance is therefore isomeric with nicotine.

C. THE ABSENCE OF NICOTINE IN MATURED TOBACCO SEEDS

In order to gain some insight into the formation of nicotine in the plant, a quantitative comparison of the nicotine content of ungerminated and germinated tobacco seed was carried out. This study was undertaken to establish definitely the presence or absence of volatile bases of a complexity comparable to that of nicotine in matured tobacco seed and also to discover whether seeds germinated entirely without outside sources of food were capable of producing nicotine.

In regard to the occurrence of nicotine in tobacco seed, the literature is at considerable variance. Thus Scurti and Perciabasco (10), Paris (11), Bernardini (12), Chaze (13), and Ilyin (14) maintain that there is no nicotine in tobacco seed. On the other hand, Albo (15), Ciamician and Ravenna (16), and Klein and Herndlhofer (17) claim to have demonstrated the presence of this alkaloid in the seed. None of the investigators who have claimed that nicotine is present in tobacco seed have attempted to isolate this substance and thus conclusively establish their contention.

Little information regarding the amounts of nicotine present in very young tobacco plants has been published and, as far as we have found, no one has reported the isolation of this alkaloid from such material. Chuard and Mellet (18) reported no nicotine in 20 day old plants, while in plants at 50 days, the leaves contained

0.33 per cent and the roots 0.15 per cent. Chaze (13) demonstrated the presence of nicotine in 1 mm. plants by a histochemical technique with Bouchart's reagent. Paris also states that germinating seed contains a small quantity of nicotine.

a. *Experiment 1.* 20 gm. finely ground seed of Cuban shade tobacco were suspended in water, an excess of sodium hydroxide was added and the material was distilled witb steam into N/10 hydrochloric acid until 2 liters of distillate had been collected. The distillate was concentrated at a reaction of pH 4.0 *in vacuo* to a volume of 50 cc. On the addition of silicotungstic acid no precipitate was formed.

b. *Experiment 2.* 100 gm. of seed of Connecticut Havana tobacco were extracted three times with boiling water. The extract was concentrated *in vacuo* to a volume of 200 cc. and 100 cc. of this extract (50 gm. seed) were distilled at alkaline reaction with steam into acid and the distillate was concentrated to 50 cc. On the addition of silicotungstic acid no precipitate was obtained. Several other experiments on different batches of seed were carried out with similar negative results.

According to Rasmussen (19) silicotungstic acid will give a detectable precipitate with nicotine in a dilution of 1:300,000. Since, in Experiment 2, a distillate from 50 gm. of seed gave no precipitate with silicotungstic acid, it may be concluded that matured tobacco seed contains only undetectable traces of nicotine, confirming the recent experimental work of Ilyin. This investigator found that immature seeds contain some nicotine (substances precipitable with silicotungstic acid) which progressively diminishes until complete disappearance at full maturity. This observation probably explains the conflicting views in the literature on the occurrence of nicotine in tobacco seeds, since some of the investigators may have been dealing with mixtures of immature and mature seeds.

d. THE ISOLATION OF NICOTINE FROM 9-11 DAY GERMINATED TOBACCO SEED

Preparation of Material. Seed of Cuban shade tobacco which showed 90 per cent germination and contained no nicotine was germinated in the dark on blotters for from 9-11 days until a growth of about 2-3 cm. was obtained. The seedlings were then removed from the blotters and, after weighing, were transferred immediately to a closed vessel containing chloroform. The material was held in an atmosphere of chloroform for 2-3 hours and then spread out on shallow pans and dried overnight at 60-70° C. The dry material could be separated by means of sieves into two rts. The separation was not perfect, but two fractions were obtained, one of which contained the greater part of the cotyledon and hypocotyl, and the other chiefly the seed coats and ungerminated seeds.

Preparation of Extracts. Samples of these two fractions and also of the original seed each weighing 100 gm. were extracted three times by boiling with ten times their weight of distilled water. The aqueous extracts were concentrated *in vacuo* and made to a definite volume for subsequent analyses. They are referred to in what follows as the hypocotyl-cotyledon extract, the seed coat extract, and the seed extract.

Isolation of Nicotine from the Hypocotyl-Cotyledon Extract. 100 cc. of the water extract of the cotyledons and hypocotyls, equivalent to 19 gm. dry substance, were concentrated *in vacuo* to a thick sirup after the addition of 5 cc. 2N hydrochloric acid. The sirup, after the addition of an excess of sodium hydroxide, was distilled with steam, with the constant addition of a little butyl alcohol to prevent foaming, into an excess of hydrochloric acid until about 1000 cc. of aqueous distillate had been collected. The distillate was concentrated *in vacuo* to 25 cc., was made alkaline with sodium hydroxide and extracted with ether. After *cautious* evaporation of the ether 30 mg. of a light yellow oil with the characteristic odor of crude nicotine remained. The oil was dissolved in 5-10 cc. of water and poured into 25 cc. of a saturated aqueous solution of picric acid. A voluminous yellow precipitate immediately formed and 50-60 cc. of boiling water were required to effect its complete solution. When the solution was cooled characteristic needles of nicotine dipicrate separated. These were filtered off, washed with water and alcohol and dried. The crystals sintered at 218° and decomposed at 220-221° C. After recrystallization from water the decomposition point was raised to 224-225° C., and a mixture of this material with a sample of pure nicotine dipicrate showed no depression of the decomposition point.

It is therefore clear that nicotine is present in the sprouts and cotyledons of tobacco seed after only 9-11 days of germination. It is also evident that nicotine can be synthesized by the plant from the reserve of food material in the seed at a very early stage of growth and, unless one is prepared to admit that atmospheric nitrogen enters into the reaction, that outside sources of nitrogen are not called upon at this stage for the synthesis. These experiments strikingly confirm the work of Mothes (5), who found that nicotine synthesis takes place during the early growth of the plant.

NITROGEN DISTRIBUTION IN GERMINATED AND UNGERMINATED SEED

In view of the demonstration that nicotine is synthesized by the germinating plant from its own reserve of food material it was interesting to investigate the distribution of the nicotine nitrogen as well as the other forms of nitrogen in the extracts of the germinated and ungerminated seed. These data are presented

here in detail since only a limited number of analyses of tobacco seed before and during the early stages of germination are recorded in the literature. Paris (10) records an incomplete analysis of mature tobacco seeds. Ilyin (14), whose paper was received during the preparation of this bulletin, presents analyses of some of the nitrogenous constituents of three types of oriental tobacco seed. Ilyin also studied the distribution of nitrogen in

TABLE 21. ANALYSIS OF UNGERMINATED AND GERMINATED SEED IN PER CENT OF DRY WEIGHT

	Ungerminated seed	Ungerminated oriental tobacco seed[1] Ilyin (14)	Germinated seed: Seed coat	Germinated seed: Cotyledons Hypocotyls	Germinated oriental tobacco seed[1] Ilyin (14)
	%	%	%	%	%
Total Insoluble Solids	**80.40**	....	**88.51**	**77.80**	....
Insoluble inorganic	1.32	....	2.64	2.21	....
Insoluble organic	79.08	....	85.87	75.59	....
Total Soluble Solids	**19.60**	....	**11.49**	**22.20**	....
Soluble inorganic	2.59	....	1.32	3.35	....
Soluble organic	17.01	....	10.17	18.85	....
Reducing substances (as glucose)	0.00	....	2.60	8.09	....
Total Nitrogen	**4.06**	**4.02**	**3.96**	**5.56**	**4.78**
Insoluble nitrogen (chiefly protein)	3.46	3.87	3.39	4.15	3.94
Soluble Nitrogen	**0.60**	0.15	**0.57**	**1.41**	0.84
Ammonia nitrogen	0.02	....	0.06	0.13	0.13
Nitrate nitrogen	0.03	....	0.00	0.00	....
Amide nitrogen	0.06	....	0.04	0.10	0.27
Nicotine nitrogen	0.00	0.001	0.01	0.05	0.05
Unknown volatile base nitrogen	0.01	....	0.03	0.04	....
α amino nitrogen	0.09	....	0.15	0.43	0.43
Peptide nitrogen	0.13	....	0.04	0.02	....
Other nitrogen (unknown forms)	0.26	....	0.24	0.64	....
Basic nitrogen	0.11	....	0.06	0.20	....
Non-basic nitrogen	0.29	....	0.29	0.64	....
Reaction of Extract (pH)	**6.72**	....	**5.82**	**5.23**	....

these seeds at germination intervals of 5-15 days. However, no similar data have been recorded, as far as we are aware, on the type of tobacco seed used in these investigations. For comparative purposes the averages of the figures obtained by Ilyin are appended to the data presented in Tables 21 and 22. Our analyses were performed on the three extracts whose preparation has already been described. Duplicate determinations were made in all cases by the following methods:

Total nitrogen—Kjeldahl.

Ammonia nitrogen—Colorimetric with permutit, see Vickery and Pucher (20).

Nitrate nitrogen—Modification of Jones method, see Vickery and Pucher (21).
Amide nitrogen—Method, see Vickery and Pucher (20).
Nicotine—Silicotungstic acid method (22).
Unknown volatile bases—Total volatile base nitrogen by titration minus nicotine nitrogen minus ammonia nitrogen.
α amino nitrogen—Van Slyke method (23).
Peptide nitrogen—Hydrolysis of extract with 8N sulphuric acid and determination of increase of α amino nitrogen by Van Slyke method.
Basic nitrogen—Nitrogen in phosphotungstic acid precipitate of hydrolyzed extract according to Osborne and Harris (24).
pH—Quinhydrone electrode.

Table 21 presents the data obtained upon germinated and ungerminated seeds calculated to per cent of the dry material.

TABLE 22. DISTRIBUTION OF THE NITROGEN IN UNGERMINATED AND GERMINATED SEED

	Total soluble nitrogen			Total soluble and insoluble nitrogen		
		Germinated seed			Germinated seed	
	Ungerminated seed	Seed coat	Cotyledons Hypocotyls	Ungerminated seed	Seed coat	Cotyledons Hypocotyls
	%	%	%	%	%	%
Ammonia nitrogen	3.33	10.53	9.22	0.49	1.52	2.34
Nitrate nitrogen	5.00	0.00	0.00	0.74	0.00	0.00
Amide nitrogen	10.00	7.02	7.08	1.48	1.01	1.80
Nicotine nitrogen	0.00	1.76	3.54	0.00	0.25	0.90
Unknown volatile base nitrogen	1.67	5.27	2.84	0.25	0.76	0.72
α amino nitrogen	15.00	26.30	30.5	2.22	3.78	7.73
Peptide nitrogen	21.7	7.02	1.42	3.20	1.01	0.36
Other nitrogen • (unknown forms)	43.3	42.1	45.4	6.41	6.06	11.51
Total soluble nitrogen				14.79	14.39	25.36
Insoluble nitrogen (chiefly protein)				85.21	85.61	74.64
Basic nitrogen	18.3	10.5	14.2	2.71	1.52	3.60
Non-basic nitrogen	48.4	50.8	45.4	7.15	7.33	11.51

It will be observed that the aqueous extract of ungerminated seed is less acid than that from the germinated material.

In Table 22, the proportions of the different forms of nitrogen have been recalculated as percentages of the total soluble nitrogen and of the total nitrogen respectively. These figures show that about 3.5 per cent of the soluble nitrogen, equivalent to 0.90 per cent of the total nitrogen of the cotyledons and hypocotyls, and about 1.8 per cent of the soluble nitrogen, equivalent to 0.25 per cent of the total nitrogen of the seed coat, is nicotine. These

[1] Average of 10-11 day germination in the dark.

figures agree in order of magnitude with those of Ilyin, who obtained about 1 per cent of the total nitrogen as nicotine at the same period of germination. During the germination, as would be expected, there is a marked increase in total soluble nitrogen, but the data indicate that the ungerminated seed is relatively higher in amide nitrogen than the germinated material. The nitrate present in seed disappears during germination.

The cotyledons and hypocotyls contained 8 per cent of reducing sugar, as estimated by the Benedict method. Glucosazone equivalent to 3.3 per cent of sugar expressed as glucose was obtained by direct isolation. Thus only about 41 per cent of the total reducing substances are represented by glucose (or fructose). The remaining reducing substances may consist of other carbohydrates or of substances of unknown nature.

THE OCCURRENCE OF NITRATE NITROGEN IN TOBACCO

It is stated in the literature that tobacco contains nitrate. The quantities generally reported are, however, small. In the course of our work certain samples of tobacco were encountered which

TABLE 23. VARIATIONS IN NITRATE CONTENT OF GREEN TOBACCO GROWN UNDER DIFFERENT CONDITIONS

	Nitrate N / Total N	Nitrate N / Total soluble N	Nitrate N / Dry weight
	%	%	%
No. 1 Nitrogen starved	0.0[1]	0.0	0.00
No. 2 KNO_3 fertilizer	14.7	45.0	0.72
No. 3 Organic fertilizer	23.2	53.0	1.19

contained unusually high proportions of nitrate. In view of this a brief study was made of some of the factors that contribute to the high nitrate content of tobacco. Experiments were also conducted with the object of demonstrating conclusively that the substance which is estimated as nitrate by indirect methods actually is this substance.

The data reported in Table 23 show the extremes of the variation in the nitrate content of the tobacco samples we investigated. These samples were grown in the hothouse and differed only in the type and quantity of nitrogenous fertilizer received. The plants in Experiment 1 received no fertilizer; they were dwarfed and the leaves were yellow in color. In Experiment 2 the plants received daily as much potassium nitrate solution as they would endure. Growth was abundant and the plants were normal in appearance. The plants in Experiment 3 received their nitrogen in the organic form from castor pomace and cotton seed meal. Here also normal growth was obtained. Aqueous extracts of the leaves of all of these plants were prepared and analyzed.

[1] Negative diphenylamine reaction.

These data indicate that the nitrate nitrogen may vary from zero to 23 per cent of the total nitrogen or from zero to 50 per cent of the total soluble nitrogen of the plant. From samples 2 and 3 nitron nitrate equivalent in amount to more than 90 per cent of the indicated nitrate content was isolated in the crystalline form.

Wide variations in the proportions of nitrate nitrogen may also occur in tobacco plants grown under field conditions. The data in Table 24 represent analyses of dried cured samples of 1927 field crops grown on plots with different sources of nitrogenous fertilizers.

TABLE 24. VARIATIONS IN NITRATE CONTENT OF CURED TOBACCO GROWN UNDER DIFFERENT CONDITIONS

	Nitrate N / Total N	Nitrate N / Dry weight
	%	%
No fertilizer	3.54	0.113
Sodium nitrate	3.54	0.093
Castor pomace	4.92	0.121
Calcium nitrate	7.64	0.213
Cotton seed meal	9.27	0.296
Urea	16.21	0.598
Ammonium sulphate	19.48	0.779

The nature of the fertilizer employed exerts considerable influence upon the proportion of nitrate in the cured tobacco. The low values obtained with sodium nitrate fertilization are unquestionably due to the fact that 1927 was a very rainy season and soluble salts, such as sodium nitrate, were leached from the soil before maximum storage in the plant could take place. The highest values were obtained with ammonium sulphate. This material is not readily leached out of the soil and consequently the plants had a continuous available source of nitrogen. It is evident from both Table 23 and 24 that the nitrate nitrogen found in tobacco may vary over a wide range, depending upon the rainfall during the growing season as well as upon the type of nitrogenous fertilization employed.

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FIELD EXPERIMENTS ON BROWN ROOTROT[1]

H. F. Murwin,[2] G. P. Clinton and P. J. Anderson

During the seasons of 1925, 26, 27 and 28, field experiments on brown rootrot were conducted on a badly infected acre of tobacco land on the farm of T. F. Connor of Poquonock. No previous report of these experiments has been made. Although, in general, the results only confirm those which have been obtained in other sections, notably Massachusetts and Wisconsin, nevertheless it seems worth while to publish them as confirmatory evidence and also for the information of Connecticut growers who may not have access to publications from other states on this subject.

OCCURRENCE AND SYMPTOMS

Brown rootrot occurs wherever tobacco is grown in New England, as well as in at least the majority of the tobacco growing sections of America. The disease is not new. Within the last fifteen years experiment station workers have studied and applied this new name to a stunted and uneven condition of tobacco crops which were planted on sod land or after certain other crops which appear to have an adverse effect on a following tobacco crop. That such an after effect existed has been known for generations.

The most readily observed symptom of the trouble above ground in the field is stunted growth. In the majority of instances the field is not affected throughout, but only in patches of irregular sizes and shape. This gives the field a non-uniform appearance. In places the tobacco appears normal in size, while in others it hangs back and appears to stop growing altogether. During hot days, plants in affected spots wilt more quickly. Affected plants do not die, but look unhealthy and stunted. From the symptoms *above ground, a case of brown rootrot cannot be distinguished* from black rootrot or various troubles caused by unfavorable soil conditions.

The only certain diagnostic character of the disease is the presence of dead roots of a brown color, the number of which depends on how severely the crop is affected. Roots of all sizes may be attacked. With the continuous dying of its roots the plant is stimulated to the production of an abnormally larger number

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[1] Coöperative investigations between the Bureau of Plant Industry, U. S. D. A., and the Conn. Agr. Exp. Sta.

[2] Superintendent, Dominion Experimental Station, Harrow, Ontario, Canada, and formerly Agent, Office of Tobacco Investigations, Bureau of Plant Industry, U. S. D. A.

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of smaller roots which also continue to die, resulting in the production of a brush-like tuft of brown roots at the bottom of the stalk. Roots above the brush are likely to be larger and not so much affected. When the roots are washed and examined closely, it will be found that in the early stages of infection, a root will show brown dead areas or lesions, while the remaining portions of the root may be still white and healthy.

These root symptoms are the only ones by which the disease can be identified and when it is recalled that the natural color of any dead tobacco root almost irrespective of the agent which killed it, is brown, it is easy to understand why there has been so much uncertainty in its diagnosis and so much confusion and diversity of opinion as to its cause.

CAUSE

Various causes of brown rootrot have been suggested and most of them supported by a certain amount of evidence. A review of the evidence for and against each would add nothing to the present discussion and will therefore not be attempted. This much is, however, certain:

1. It has not been shown that any organism, parasitic or saprophytic, is the cause.
2. There is abundant evidence that a preceding crop may cause it. But there is no considerable uniformity of opinion as to how the preceding crop operates to produce such a result.
3. Certain fertilizers, soil amendments or toxins have been shown to produce brown dead roots on tobacco plants under certain conditions, but it is not at all sure that this is the same trouble which is commonly observed in the field. In fact it is not at all certain that there is one single cause of brown rootrot. There may be a number of agents, any one of which may produce brown rootrot under the right conditions.
4. All soils do not react alike to the same causal agents, that is, on some soils it seems to be possible to produce a perfectly normal crop on sod land, while in adjacent fields the results may be failure. The same difference may be seen in spots of the same field, even where previous treatment of the whole field was the same.

PLAN AND PURPOSE OF THE EXPERIMENT

The field experiments at Poquonock were undertaken with the object of determining further the effect of preceding crops and of other cultural practices on the development and on the prevention of brown rootrot. Specifically the questions for which an answer was sought were:

1. *Do certain preceding crops cause rootrot? Will the omission of these crops cure the trouble?*
2. *What effect has manure on rootrot?*
3. *What is the effect of lime?*
4. *Will fallowing be a benefit to affected land?*
5. *Will an acid fertilizer have any effect on rootrot?*
6. *Is the disease affected by the time of plowing the land?*
7. *Can it be cured by sterilization of the soil?*

The field was divided into one twentieth acre plots. All treatments were in duplicate and the figures presented in the tables

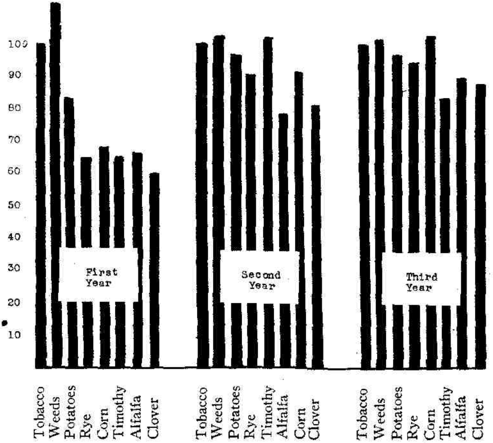

FIGURE 14. *First, second and third crops of tobacco after one year of rotation crop* (tobacco after tobacco = 100).

below represent the average yield of the two, calculated to an acre basis. Although the tobacco was sorted and percentages of grades recorded, they are not presented here, because in this investigation we are dealing more with yield than with quality. Results were judged first on the basis of yield and secondly from examination of roots for the symptoms of disease.

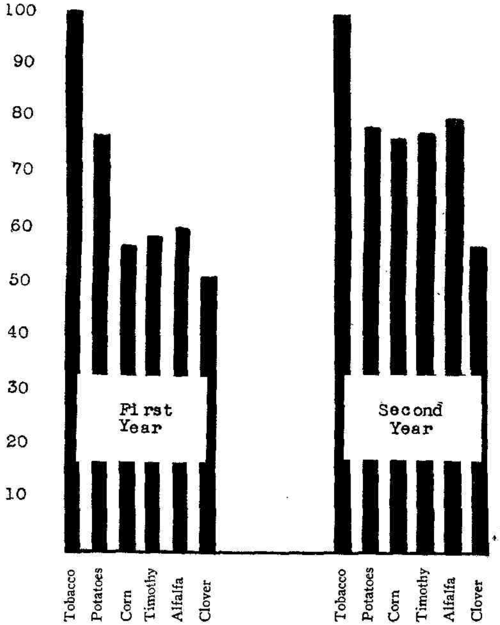

FIGURE 15. First and second crops of tobacco after two years of rotation crop.

EFFECT OF PRECEDING CROPS

In 1925 the following crops were grown on duplicate plots:

1. Potatoes.
2. Corn.
3. Timothy.
4. Alfalfa (with nurse crop of oats).
5. Clover (with nurse crop of oats).

6. Rye. This crop had been grown in 1924 but was not harvested. Old straw rotted on ground in 1925 and self seeded.
7. Weeds. Plowed, then left to grow up in natural weed vegetation during 1925.

In 1926 one-half of each plot was set to tobacco, and the alternating crop repeated on the other half.

In 1927 and 1928 tobacco was raised on all plots.

This arrangement afforded an opportunity to measure the result of either one year or two years of each crop and also to get the after effects during the next two years. Yields under these different conditions are shown in Tables 25 and 26 and graphically in Figures 14 and 15.

Table 25. Yield of First, Second and Third Crops of Tobacco After One Year of Other Crops

Preceding crop	Pounds to acre First crop 1926	Second crop 1927	Third crop 1928
Tobacco	1181	1110	1167
Timothy	765	860	974
Corn	798	1146	1198
Alfalfa and oat	787	1017	1050
Clover and oat	709	915	1031
Potatoes	979	1071	1133
Rye	765	1013	1111
Weeds	1327	1138	1179

Table 26. Yield of First and Second Crops of Tobacco After Two Years of Other Crops

Preceding crop	Pounds to acre First year 1927	Second year 1928
Tobacco	1110	1167
Timothy	665	891
Corn	628	885
Alfalfa and oats	669	932
Clover and oats	561	767
Potatoes	852	893

A study of these tables shows that the yield is materially reduced when tobacco follows the other crops, the reduction in yield being somewhat greater when following two years of the preceding crop. The forage crops, timothy, alfalfa, clover and corn are particularly injurious. Potatoes cause less reduction than the forage crops. Plowing under a crop of rye straw from the second preceding year has had the same injurious effect as the forage crops. The best results were obtained by abandoning the field to natural weed growth for a year.

Decided recovery was observed in the second tobacco crop after the forage crop, complete recovery in the case of corn. This recovery was more pronounced during the third year but was not yet complete for all of them.

Roots from each plot were washed and examined for disease immediately after harvest each year. When the root condition of the different plots was tabulated and compared with the yields, there was found to be a fairly constant relation, which was, the more severe the root lesions, the smaller the yield. From this, it is safe to conclude that the low yields are due to brown rootrot and that the weight of cured tobacco is a measure of the percentage of infection on the roots.

CONTINUOUS TOBACCO

The first year of this experiment, 1925, was a good growing season and yields on adjacent fields were high, yet, on the check plots of this field the average yield to the acre was only 860 pounds and the roots were found to be badly diseased. The increased yields of the following years (Table 25) and the root examinations show that there was a decided recovery when tobacco was grown continuously on the same plots. There may be an objection that the yields of 1926, '27 and '28 on all the plots were too low for profitable tobacco growing. This was largely due, however, to unfavorable weather conditions. On account of excessive rainfall, the crops of 1927 and 1928 were unusually light throughout this section. A severe hail storm in 1927 further reduced the yield of that year. This field was set to tobacco again in 1929 and although no yield records were taken, observations indicated that the crop on the whole was about normal.

These results agree with those obtained in other states, showing that the continuous growing of tobacco on the same land reduces brown rootrot damage.

FALL PLOWING

Two plots were plowed in the fall and only disked in the spring. Two others were plowed in both fall and spring. Yields on these plots were as follows:

	1926	1927
Plowed only in fall	1181	1103
Plowed fall and spring	1181	1117

These figures do not indicate that plowing in both fall and spring produces any better results than fall plowing only.

MANURE

Two plots had an application of manure at the rate of 20 tons to the acre in the spring of 1925, 1926 and 1927. This was in addition to the regular application of commercial fertilizer. Yields on these plots as compared with no manure plots were:

	1925	1926	1927	1928
Manure	1219	1361	1247	1191
No manure	860	1181	1110	1167

Observations in the field during the first years of the experiment showed marked improvement in growth where manure was added. The yields for the four years were higher than on the unmanured plots. The fact that one of the manure plots was on a corner of the field which was not so badly affected with rootrot may have accounted for some of this difference. Nevertheless it was evident throughout the series that manure was beneficial on this land.

ACID FERTILIZER

On two of the plots a special fertilizer mixture, designed to give the soil a more acid reaction, was used instead of the regular mixture which was applied to the other plots. This mixture differed from the regular formula in having more than half of its nitrogen from sulfate of ammonia and was composed as follows:

1100 lbs. cottonseed meal
440 lbs. sulfate of ammonia
315 lbs. double superphosphate
367 lbs. sulfate of potash

Yield on these plots as compared with those where the general fertilizer was used were:

	1925	1926	1927	1928
Acid fertilizer	931	1248	824	918
Neutral fertilizer	860	1181	1110	1167

Apparently there was a slight improvement during the first two years, but it was followed in the succeeding two by a serious decline. Last year these plots showed the symptoms of manganese poisoning. This is characteristic of a soil which is too acid for tobacco. Since root examinations during the last years showed that these plants were practically free from root lesions, it is safe to conclude that the reduced yield was due to the very acid soil rather than to rootrot. When the series was started in 1925, this soil tested 4.91 pH. In the fall of 1927 the acid plots tested 3.81, mucb more acid than any other plot on the field.

We may conclude then that although an acid fertilizer may have a strong effect in eliminating brown rootrot, yet the injury from the increased acidity may be more disastrous than that from rootrot.

LIME

Two of the plots were limed at the rate of one ton to the acre of air slaked lime in 1925, 1926 and 1927. Yields on these plots as compared with the unlimed plots were:

	1925	1926	1927	1928
Limed	958	1316	1262	1246
Not limed	860	1181	1110	1167

Starting with a reaction around 5.0 pH at the beginning of the experiment, the limed plots had reached a reaction of 6.7 pH, in

the fall of 1927, much more alkaline than any of the other plots. Such a reaction is usually favorable to *black* rootrot, but this disease never became prevalent on this field. The yield data indicate that there has been considerable benefit from the use of lime on this particular field.

FALLOW

When the first crop of this experiment was set in 1925, two plots were left without any plants. No fertilizer was applied, but they were plowed, harrowed and cultivated throughout the season, just as the plots which had tobacco on them.

In the next three years, they were fertilized and set to tobacco. Yields for these years were:

	1925	1926	1927	1928
Fallowed	....	1170	1169	1197
Not fallowed	860	1181	1110	1167

These data show that fallowing has caused recovery to about the same degree as the continuous growing of tobacco, that is, the yield of the first crop after one year of tobacco was approximately the same as after one year of fallow. Examination of the roots showed reduction in severity of infection at about the same rate as the increase in yield.

STERILIZING THE SOIL

In 1925, two plots were sterilized with steam—the ordinary steam pan method used on tobacco beds, and two others were sterilized with formaldehyde diluted one part in 25 of water and applied at the rate of one quart a square foot of soil. Yields on these plots for four years were:

	1925	1926	1927	1928
Not sterilized	860	1181	1110	1167
Sterilized with formaldehyde	1125	1283	1161	1211
Steam sterilized	1575	1530	1181	1214

Steaming the soil almost doubled the yield the first year. Root examination at the close of the season showed that the disease had been completely eliminated by this treatment. Steaming was not repeated the following years, but the benefit the second year was nearly as large as the first year and improvement was apparent in the field even in the third and fourth.

Formaldehyde greatly increased the yield the first year, but it was not as effective as steam. After the second year, the effects of the two were about the same.

A third method of sterilizing the soil was tried in a small way. Soil from the worst affected plots was spread in a thin layer on a board floor to dry and aerate for two weeks. A like amount of

soil from the same plots was kept in moist condition. Both soils were then put into separate pots and one tobacco plant was grown in each of eight pots. The plants in the aerated soil grew much more rapidly than the others, which were stunted. At the end of six weeks, the former weighed approximately ten times as much as the latter. Root examination showed that aeration had eliminated the disease from the soil.

Because of the expense, these methods of sterilizing the soil will probably never be practical in the field in a large way, but they may be useful on small spots. They are of considerable interest for the information they may furnish as to the nature of the disease.

SUMMARY

The type of brown rootrot which was present in this field is closely associated with the previous cropping system.

It becomes most severe when tobacco follows the forage crops, timothy, corn, rye, alfalfa or clover.

Potatoes are less injurious in this respect than the forage crops.

With continuous tobacco culture, injury is reduced to a very low amount.

Fallowing without fertilization has the same effect as continuous tobacco.

Abandoning the land to the natural weed growth for a year was more beneficial than either continuous tobacco cropping or fallowing.

Addition of stable manure increased the yield on this field.

Annual applications of lime were beneficial.

Use of an acid fertilizer reduced the disease on the roots, but did not increase yield, because the soil became too acid for good growth.

The disease can be completely eliminated by steaming the soil or thoroughly aerating it. Sterilizing by formaldehyde is less beneficial than the other methods.

Time of plowing the land as practiced in this experiment had no effect on the severity of the disease.

RECOMMENDATIONS

On the basis of these experiments, supplemented by results of experiments in other sections, we recommend the following to the tobacco grower who has trouble with brown rootrot:

1. Do not attempt to rotate tobacco with other crops. Avoid particularly the forage crops. Do not use timothy cover crops on land which shows a tendency toward brown rootrot.

2. Continuous tobacco culture is better than trying to "rest" the land by growing other crops. If there is opportunity to rest the land, let it grow up to the natural weed vegetation for a year or longer.

BLACK ROOTROT RESISTANT SHADE TOBACCO

John G. Wolf

Black rootrot of tobacco, caused by the fungus *Thielavia basicola* Zopf, has inflicted heavy loss on growers of shade tobacco. The disease prevents the normal growth of plants and thus reduces the yield, even on soil which has all the necessary plant nutrients.

Much of the so-called "running out of tobacco soils" is due to rootrot. When such crops as tobacco are grown year after year on the same land, the soil may eventually become infested with disease organisms and so be unsuitable for further growing of that crop.

The problem, then, is to produce a tobacco plant that will mature normally, season after season, on the same field. With this object in view the writer has carried out his investigations at the tobacco substation the last three seasons.

In the last quarter of a century, a great many disease-resistant crop plants have been developed. Among them are wilt-resistant cowpeas, wilt-resistant sea island cotton, alfalfa resistant to leaf spot, cabbage resistant to yellows, rust-resistant wheat, spinach resistant to yellows, rust-resistant asparagus, watermelon resistant to anthracnose, and smut resistant corn.

In tobacco, black rootrot-resistant strains have been found in the White Burley type, Wisconsin Havana Seed and Pennsylvania Broadleaf. No degree of resistance has ever been found in any strain of Connecticut shade tobacco.

In almost every instance, the first plant selections for resistance were made in fields where the crop was practically a failure, except for a few plants, possibly naturally immune, which stood above the others and seemed perfectly normal. Using these apparently resistant plants as a starting basis, eliminating all possible crossing by selfing, and using rigorous row selections for several generations, strains have been developed with the desired inheritance and a high probability of breeding true. Especially is this true with tobacco, which is normally self-fertilized.

Hugo De Vries, a Dutch botanist, described the appearance of new characters which were departures from normal. These he called "mutations." This change may be in only one visible feature, such as form of leaf, color of flower, or height of plant. They occurred in such a way that they could not be due to Mendelian segregation and many were proved to be actual germinal changes.

Author's Acknowledgment. The writer acknowledges his appreciation and indebtedness for helpful suggestions and criticisms of Dr. Paul J. Anderson, pathologist-in-charge of the tobacco substation, and to Dr. Donald F. Jones, geneticist of the experiment station.

In self-fertilized species, these occurrences are extremely rare, but when found they may be assumed to be mutations and to have the potential ability to breed true. In cross-fertilized plants there is a greater chance to select desirable combinations of disease resistant factors.

It is well to note that a normally resistant plant in a certain locality may be a failure in some other geographical center, which is probably due to higher specialization of fungi to the host. Also, it is often difficult to obtain a uniformly "infected" soil for experimentation. In our investigation, at the J. Ford Ransom lot in Windsor, only about one-half of the area in use was found to be badly infected with rootrot.

FIGURE 16. Field of Cuban shade tobacco showing the desirable uniformity of stand when no rootrot is present.

SYMPTOMS OF BLACK ROOTROT

This disease is prevalent in all the tobacco growing sections of the northern states and in Europe. Its presence in the tobacco field first becomes known to the farmer when he notices that the plants in certain parts of his lot lag behind the rest of the field. Some may stop growing completely. On hot days the affected plants wilt and the leaves flag. When the plants are pulled, many of the lateral roots are seen to be rotted off. The diseased portions of the roots are dark brown to black, instead of white, as a healthy root should be. On smaller roots the lesions go completely through and the root drops off, but on larger laterals the lesions

appear as black, rough enlargements, while the center of the root may still be healthy. Loss of the roots has a direct connection with the flagging leaves, since the reduced root system is unable to supply enough water to equal the volume which is transpired by the leaves on a hot day.

Soils particularly conducive to rootrot are those which are heavy and cold, apt to be water-logged, those which are nearly neutral in reaction, usually due to liming, and those which have been manured heavily.

IMPORTANCE OF BLACK ROOTROT TO THE SHADE INDUSTRY

Shade tobacco is more susceptible to black rootrot than either of the other two types of tobacco grown in Connecticut. Although it is well known to all shade growers that thousands of acres of shade land have "run out" since this type has been grown on it, it is not so well appreciated that most of this "running out" is due to increase in prevalence of the black rootrot fungus in the soil. When the reduced yield makes it no longer profitable, this land must be abandoned for a time and the poles and wire transferred to other land. This transfer, the added expense of leasing or purchasing new land, the necessity of operating at a distance from home and frequently from convenient sheds, all must be computed in the bill which the grower pays to rootrot. If it were possible to calculate in dollars the loss the growers have sustained from these operations and from the reduced yields, the figure would be in millions. Suffice it to say that it is the most serious disease problem with which the shade grower must contend.

ORIGIN OF THE 4R RESISTANT STRAIN

Since resistant mutations have been found in other types of tobacco, it was not unreasonable to believe that one would be found sometime in the Cuban Shade type. Although many fields had been carefully searched for years, no indication of resistance was found until 1927. In July of that year it was discovered on the badly diseased part of a shade field, owned by Mr. Ransom, that a few strong luxuriant plants grew twice the height of the sickly little ones about them. They had sturdy stalks in contrast with the "pipe stem" stalks of the other plants. These large plants were not grouped in one place, but were scattered singly over more than half an acre. This part of the field had suffered from rootrot several years before 1927. When some of the *little* plants were now dug up they showed a badly rotted root system, characteristic of black rootrot.

Close examination and testing of the soil at the base of the few large normal plants failed to show any difference between this and the soil in the rest of the field. In leaf shape and other

growth characteristics, these plants were like the normal plants from the unaffected part of the field. There was therefore no reason to suspect that these plants were a different type of tobacco, accidentally introduced, or that they were affected by any soil differences. They could only be a mutation or a hybrid from some previous crossing.

Inquiry revealed that the seed was the same as the owner had been using for several years. It was originally from the same strain as that grown by the other shade growers, the Hazelwood type, brought from Cuba by William Hazelwood in 1903, and selected for uniformity for a number of years by J. B. Stewart and co-workers. Mr. Stewart states that the seed which he finally distributed and is now universally grown in the valley is the progeny of a single plant which they selected. Therefore it does not seem likely that these plants could have come from segregation in a hybrid population.

Althougb the diseased plants "spindled up" taller in the latter part of the season, they *never* produced leaves of any commercial value and were always much inferior to the mutants in size. The seed beads of 18 of the larger plants were bagged to prevent any accidental crossing. The progeny of this seed was subsequently designated as the "4R strain" (abbreviation for Ransom Rootrot Resistant) to distinguish it from the ordinary shade tobacco.

After the seed had been harvested, the root systems of the bagged plants and of neighboring *small* plants were washed and examined. The root system of the susceptible plants was badly diseased, most of the lower roots being mere stubs. The best roots were at the top and had developed after the bottom ones had been rotted away. The root system of each of the 18 healthy was several times as large as the others and was characterized by strong long laterals *at the bottom*. There were lesions of black rootrot, however, even on these roots, but not nearly so numerous as on the susceptible plants and the injury was small. Apparently we had here, not immunity, but a high degree of resistance, or, possibly, it might be called increased root vigor.

FURTHER TESTING OF THE 4R STRAIN IN 1928

This rootrot infested field, where the first selections were made, was kindly made available by Mr. Ransom to continue the selections under an environment favorable to development of the disease.

The selfed seed, obtained from the selected plants of 1927, were sown in 1928, the progeny of each plant being kept separate. In the bed no variation could be discerned between the resistant and the ordinary Cuban seedlings, both being vigorous and normal.

Late in May, these plants were set in the Ransom lot and also in an uninfested shade field on the station farm in order to observe

the quality of the product under normal conditions. The regular Cuban was used as a check in both fields.

Early in the growing season, it was noticeable that many rows showed considerable vigor and some resistance when compared with the checks. Unfortunately for the experiment, this was a poor rootrot year, for the plants brought to the laboratory in July showed but little infestation, while the check rows had slightly more. Later observations taken on field growth showed the resistant rows to be far superior to the checks, in vigor and general growth.

About the middle of July, the best plants from the best rows

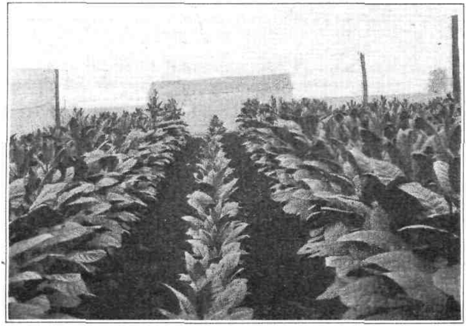

FIGURE 17. Row of common Cuban between rows of 4R Cuban. All set the same day.

were selected with the assistance of two experienced shade growers, Mr. Ransom and Mr. Stewart. The object of this selection was to choose plants having ideal Cuban characteristics, leaves of good texture, proper size and shape, with a goodly number of marketable leaves and generally showing good commercial possibilities. These were properly tagged and selfed by bagging.

The plants set in the station tent afforded an opportunity for comparing the quality and the tobacco was followed through to the grading tables. These leaves showed no significant difference in quality as compared with the regular Cuban. Apparently, then, the selections must be made mostly on the basis of apparent resistance. Soil samples taken on the field showed about the same reaction as the preceding year. The root systems when dug up

and carefully examined showed those of the resistant plants to be larger, yet having a few lesions of black rootrot. Since two rows had shown most promise during the season, twenty of the best plants from these two were selected for seed with which to continue the tests for 1929.

CONTINUATION IN 1929

Seed of each of these 1928 selected plants was sown separately and one row each was set in the Ransom field early in June, 1929.

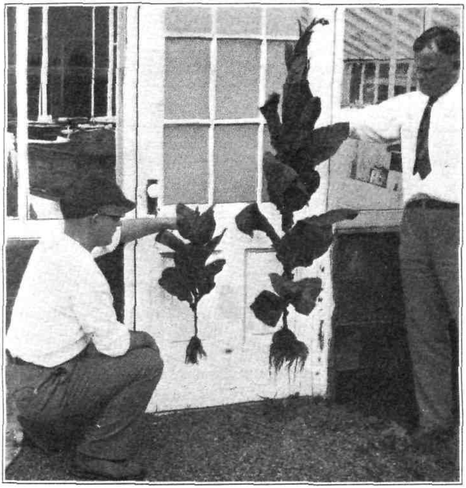

FIGURE 18. Resistant Cuban plant (4R) on right compared with common Cuban on left.

As before, ordinary Cuban was used for a check. As early as July 10, it was noticed that the check rows seemed stunted or were rather slow in starting and many rootrot lesions had developed, while the 4R strain was exceedingly vigorous and examination showed little, if any, rootrot infection.

One of the interesting facts of 1928 and 1929 was the uniformity of the plants in each of the resistant rows, which shows a definite mutational characteristic. As before, some rows seemed superior to others and showed considerable promise. This was evident on the left side of the field, where the rootrot infection had always been severe. On the right this variation was not so pronounced.

On July 16 the resistant rows far outstripped the check rows of the regular Cuban. This difference between the resistant and susceptible Cuban plants is shown in Figures 17 and 18 from photographs taken on this date. One hundred plants on the susceptible row at this time averaged 41 inches in height, in contrast

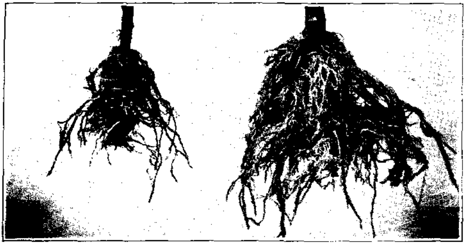

FIGURE 19. Root system of 4R Cuban plant (right) compared with that of common Cuban.

with 67 inches as the average of an equal number on the adjacent 4R row. On July 22 the 4R plants stood 24 inches higher than *those on the check rows on the left side, where the rootrot* infestation had been the worst. At this time, the resistant plants at the right, less infested part, also were taller and superior in every way to the normal check rows. The first priming of a resistant and an adjacent susceptible row was taken for measurements after curing and sweating. From these the following measurements were taken at time of sorting:

	Susceptible Cuban	Resistant 4R4
Average length of leaf	10 inches	14 inches
Average width of leaf	5 "	8 "
Weight of first picking (to acre)	175 lbs.	340 lbs.

The 4R leaves were of good size, shape and quality. The leaves of the susceptible Cuban were short, narrow, pointed and practically none was considered to be of commercial value. Also none

of the leaves above the first picking became large enough to be of any value.

In early fall, the roots were dug and examined. The root systems of the resistant plants were large, white in color, had many strong laterals and were comparatively free of rootrot lesions. On the check, they were smaller, with stubs due to rotting off and with an abundance of lesions.

Late in July the best rows were selected and the best plants selfed by bagging. On the first of August the severe hail storm hit the section, but sufficient seed to continue this strain was saved.

SUMMARY

1. A strain of Cuban shade tobacco highly resistant to rootrot, but not differing in other respects from ordinary shade tobacco, has been isolated and tested for two years in this field.

2. The strain at this time is fairly uniform, which shows it to be a mutation and not a hybrid.

3. Resistance to disease is often not absolute and the extent of infection is greatly influenced by environmental conditions. It is therefore desirable that the 4R strain be tested on other fields, The station will be glad to furnish a limited amount of this seed for trial to growers who have infested fields.

SEASONAL FLUCTUATIONS IN SOIL REACTION

T. R. Swanback and M. F. Morgan

Soil acidity, as measured in terms of pH values, has become of such great interest to tobacco growers that soil tests are being made at frequent intervals on a great many tobacco fields. A considerable amount of confusion has arisen because carefully selected soil samples of the same field frequently show pronounced variation in reaction when collected at different dates. Is this phenomenon to be ascribed to errors in sampling or in method of measurement of pH values, or does the pH of the soil actually change from time to time?

Other investigators have noted seasonal changes in the acidity of certain plots where soil conditions and methods of testing were carefully controlled. Kelley[1] found variations in pH in the same plot which amounted to 1.0 pH during the year. During the summer, with a prolonged drouth, there was a continual increase in acidity, while fall rains produced a decrease. With the coming of winter, pH values showed a slight increase in acidity when the soil became frozen, while in the spring the soil returned to a normal reaction. Baver,[2] studying changes in acidity from day to day during the summer, observed that two unlimed plots became progressively acid through the season from May to September and concluded that there is a constant increase in acidity from spring to fall, with a return to approximately the original acidity the following spring. He ascribed this seasonal trend either to the dehydration of colloids by drying of the soil, or to the accumulation of soluble salts during the snmmer.

During the past three seasons data on periodic variations in the acidity of certain plots at Windsor show that tobacco soils of the Connecticut valley may also show a similar seasonal change in pH.

SINGLE NITROGEN SOURCE PLOTS AT WINDSOR

A set of plots at Windsor, where the effect of different carriers of nitrogen is studied, has also been used to observe the soil reaction during the various seasons. Four plots were laid out in the spring of 1926: cottonseed meal, nitrate of soda, urea and sulfate of ammonia. Three were added to this series in the spring of 1929: castor pomace, linseed meal and dry ground fish.

Reactions were determined before fertilizers were applied in 1926 and 1927, and from December of that year up to date nearly every month.

The graphs in Figure 20 show that the reaction varies consider-

[1] Soil Science, 16, 46-47.
[2] Soil Science, 23, 403-407.

ably during the year. The heavy line, representing reactions on the cottonseed meal plot, probably expresses approximately the seasonal fluctuations in pH values which may occur in an ordinary tobacco soil. The differences between the summer months and other seasons may range from one-half to more than a unit pH.

Figure 20 also shows clearly the extremely acid condition which is produced by sulfate of ammonia, as compared to the tendency of nitrate of soda, while urea and the organic fertilizers are intermediate in their effects.

SEASONAL TRENDS IN CONCRETE-WALLED SOIL PLOTS AT NEW HAVEN

Since the spring of 1927, the soil reaction of forty-eight small concrete-walled soil plots has been determined at frequent intervals. Various combinations of lime, nitrogen, phosphorus and potassium have been applied from time to time in experiments with vegetable crops. Urea has been the sole source of nitrogen.

On all treatments there was an increase in acidity during the summer of 1927. Marked fluctuations occurred, since the rainfall was irregularly distributed. There was a decrease in acidity in the fall, with a slight increase in the winter period. In 1928 there was no significant increase in acidity during a summer of heavy and well distributed rainfall. Fall and winter brought slightly more acid conditions. The spring of 1929 brought a return to conditions similar to previous years, while the very dry summer showed high acidity, which decreased after heavy August rains, and increased considerably during the dry period of early autumn. The acidity was still higher than normal in December, 1929, although it showed a gradual rise in pH values (decreasing acidity).

Treatments including nitrogen showed increasing acidity during the months following their application, to a much more marked degree. The following figures, compiled from thirty-four successive dates during the period May, 1927 to December, 1929, show that the nitrogen treatment is a very important factor in accentuating these periodic fluctuations:

Treatment	Mean pH	Average departure from mean pH	Maximum pH	Minimum pH
None	4.95	.15	5.39	4.51
PK	5.07	.13	5.40	4.61
NPK	4.81	.29	5.48	4.15

NITRATE CONTENT OF THE SOIL AS A FACTOR IN SEASONAL FLUCTUATIONS

The lysimeter experiments with different sources of nitrogen on various soils have provided some data as to seasonal change in pH on soils which were also studied weekly as to nitrate nitrogen content of soil in the period from June 1 to November 22, 1929.

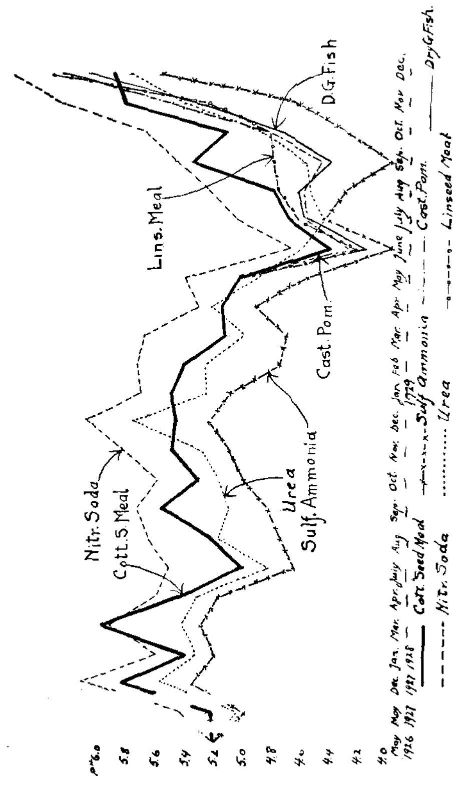

FIGURE 20. Curves of seasonal fluctuations in soil reaction on field plots at Windsor.

Four different soils were used. A fertilizer containing only the mineral elements was compared with added rates of application of nitrate of soda, sulfate of ammonia, urea and cottonseed meal,

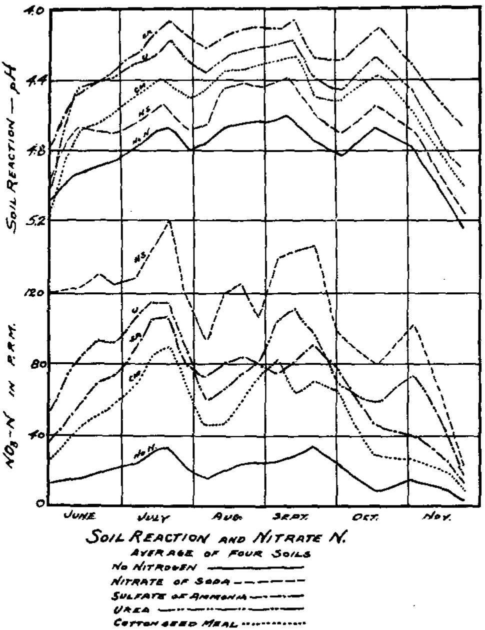

FIGURE 21.

at rates of application equivalent to 200 pounds of nitrogen to the acre, on each of the soils. The soil, in small cylinders, was kept fallow during the season.

Figure 21 shows the fluctuations in nitrate nitrogen and pH from week to week for the average values of the four soils. (It

is to be noted that the pH is plotted upside down so that if an increased nitrate content is accompanied by increased acidity, the corresponding decreased pH will show as a rise in the curve.)

A good general correlation is apparent, although the decrease in acidity does not appear to take place as quickly as the decreased nitrogen content. A similar agreement is noted with each soil, although space does not permit presentation of complete data.

Nitrate of soda, in the heavy application used in this experiment, produced an increased acidity (compared to the "no nitrogen" treatment), as long as any of the nitrates remained in the soil, although the acid-forming tendency was less marked than the three other forms of nitrogen. Urea produced practically as high an acidity as sulfate of ammonia, although its effect was less permanent.

CONCLUSIONS FROM PH FLUCTUATION STUDIES

During the late spring and early summer season, particularly after the application of high applications of nitrogenous fertilizers, there is a marked increase in soil acidity (decrease in pH). A dry season produces a more acid condition than a wet season. Withdrawal of nitrate nitrogen by the crop and the leaching of the fertilizer from the soil by heavy rains restores the pH to a normal condition in the autumn. During the winter season there are decreases or increases in acidity, which may be due on the one hand to mild periods when the frost goes out of the ground, or, on the other hand, to the accumulation of acids which are added by rain or snow and which cannot escape from the frozen soil. A return to normal conditions can be expected in the early spring.

The importance of having the tobacco soil tested for reaction has more and more been observed by the growers. From the data presented above, it is evident, however, that it is of equal importance to make allowance for the seasonal fluctuations. It seems reasonable to assume that proper times of testing the soils would be in April or October since the intermediate values are attained then.

DAMPING OFF OF YOUNG SEEDLINGS

In unsterilized plant beds in the station greenhouse, young seedlings almost as soon as they could be seen, began to die off and disappear. This continued until the few plants left were more than an inch high. They died off in bunches, particularly where the stand was thickest. This same trouble appears always to be present in the greenhouse and has been observed in seed beds elsewhere.

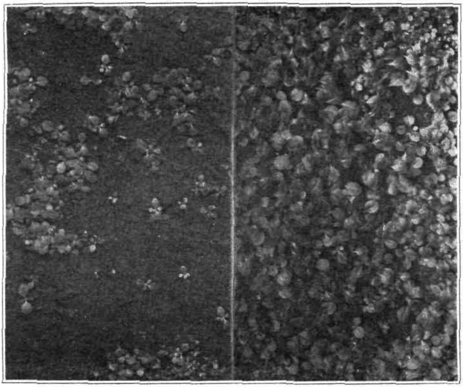

FIGURE 22. Sterilized and unsterilized plant beds. Bed to the right was soaked with 1% acetic acid.

It is not known just how prevalent and destructive it is among the tobacco plantations of the state, because no comprehensive survey has been made, but troubles which appear to be the same are common every year.

A close examination of the young plants shows that the stalk is attacked at the base between the soil and the first leaves. This part of the stalk shrivels to a string, then the plant topples over and dies on the ground. The affected part of the stem may remain green for a long time or may turn brown. Under damp conditions the top of the plant remains alive for some time after

the stem is rotted through, but finally all parts of the plant become slimy and rotten.

When the dead plants are examined under the microscope, they are found to be completely permeated with the mycelium of a fungus, Pythium. This fungus lives in the soil, but is able to attack and live on the seedlings only in their very young stages.

In order to see whether this condition could be prevented by sterilization, two new beds were started with the same soil. The soil of one was saturated with a one per cent solution of acetic acid and was seeded about three weeks later. The other was seeded at the same time without sterilization. The plants all came

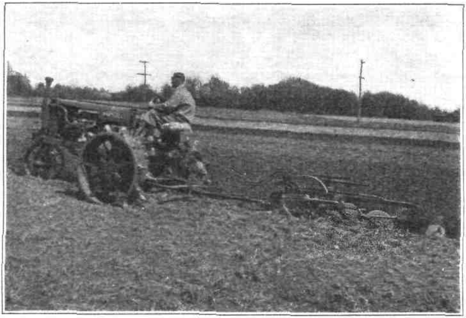

FIGURE 23. Tractor plowing in the open field.

up about alike but within a few days plants in the unsterilized soil began to disappear and the disease ran its normal course. The appearance of the sterilized and unsterilized beds when the plants were three weeks old is shown in Figure 22.

Acetic acid completely prevented the disease in the sterilized bed. Undoubtedly the same results could be obtained by sterilizing with formaldehyde or steam. Acetic acid has the advantage of being cheaper.

RAISING TOBACCO BY TRACTOR

Just as in industry, machine labor is replacing hand labor, so in agriculture, the tractor is rapidly replacing both horse and man labor. In other types of farming, this change has progressed further than in tobacco growing, but even in this intensive farming, the change is inevitable. The many obvious advantages of the tractor make it only a question of a few years and some *improvements in tractor machinery before we shall raise tobacco* without horses and with much less hand labor. The greatest obstacle to more extensive use of the tractor is the conviction of many growers that it can be used only for a part of the operations

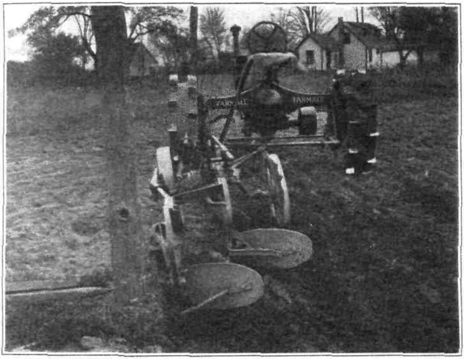

FIGURE 24. The off-set plow which will cut the furrow within two inches of the shade poles.

of growing the tobacco crop and that it will still be necessary to keep horses for the other operations. This means the maintenance of two power systems. If it could be demonstrated that the tractor can do *all* the operations just as well as horses, the substitution would be made rapidly.

To see how effectively all the operations of tobacco growing could be performed by tractor and to make improvements in tractor machinery so that it will be suitable for all necessary operations, an experiment in co-operation with the International Harvester Company was begun on the station farm. During the season of 1929 no horse was used for any operation on the farm. The

tractor grown crop was just as good as other crops. It was necessary to experiment with different types of implements, but in the end a suitable one was found for every operation.

Plowing and harrowing the open fields presented no problem because these are already common practices with many growers. The shade fields presented a different problem, the necessity of finding a plow which would turn the furrow up close to the poles and between them. The two bottom plow illustrated in Figures 23 and 24 was finally adopted as suitable for this purpose. It has a very wide adjustable offset. For the furrow directly in the pole

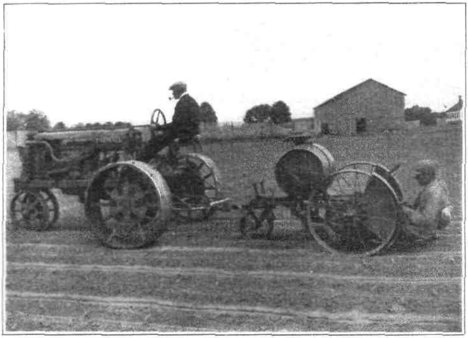

FIGURE 25. Setting by tractor. A two-row transplanter will be substituted next year for this one-row machine.

row a shift lever, not shown in the figure, was attached in such a way that the plow could be shifted around the poles. Although this did not operate as smoothly as desired, it is believed that this difficulty can be overcome so that it will not be necessary to use horses at all. The enormous saving in time and labor in fitting the land by tractor instead of horses needs little demonstration.

Shortening the pole of the fertilizer drill was all that was necessary for the operation of spreading the fertilizer. The same was true for the transplanter. The one-row setter shown in Figure 25 was an ordinary Bemis setter with a short pole. A two-row setter for this purpose has more recently been manufactured and it is preferable to the one-row setter, not only because of the saving in time, but more particularly because it keeps the distance between the pair of rows always the same. This is rather essential

for the best operation of the two-row cultivator to be used later. The uniformity of speed of the tractor and its suitability for making perfectly straight rows are distinct advantages over horses.

Cultivating was done with a two-row cultivator. The gangs of this machine are attached to the side of the tractor, where they can be watched by the driver. This also makes it possible to turn the outfit in a very small space at the end of the rows. Any combination of shovels may be used. With this outfit it is possible to cultivate until the tobacco is 30 inches high.

A stock objection to the tractor is that its weight and the broad wheels pack the soil too much. It was found in this experiment that packing could be entirely eliminated by the use of open-face wheels. For drawing the tobacco racks during harvesting it was necessary only to shorten the poles.

Further improvements are being made and the experiment will be continued, but there do not appear at present to be any great mechanical difficulties in the way of substituting tractors for horses entirely in growing tobacco.

CEL-O-GLASS SEED BED SASH

"Cel-o-glass' is a glass substitute made of fine mesh wire screen imbedded in a translucent material, light and somewhat flexible. The manufacturers, the Acetol Products Company of New York, claim that it transmits 80 percent of the sun's rays, including 35 to 40 percent of the ultra violet rays which are excluded by ordinary glass.

It has been suggested that "cel-o-glass" could be substituted for ordinary glass in tobacco seed bed sash with the following advantages:

1. It is flexible and does not break. Hence the labor and expense of replacing glass are eliminated.
2. It is lighter and does not require as heavy a frame. (Frames which we used weighed less than half as much as glass frames.)
3. The labor of handling is greatly reduced.
4. The temperature is more uniform, that is, lower during the day and higher during the night than when ordinary glass is used.

The first three are obvious, since this material is not easily broken and the sash are much lighter than those ordinarily used. To test the fourth claim we made a trial, for which the manufacturers furnished the materials. One section of the 1929 beds was covered with six cel-o-glass sash, while on the next sections the ordinary sash were used. These sections were separated from each other and from the rest of the bed by board partitions.

Observations were made throughout the season, but no continuous temperature records were made. Plants under cel-o-glass did not grow as rapidly as under ordinary glass. It required about ten more days to grow them under the substitute to a size suitable for setting. Otherwise, no differences were observed.

Bulletin 312 February, 1930

THOMAS B. OSBORNE

A MEMORIAL

Connecticut Agricultural Experiment Station
New Haven

The bulletins of this station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

Thomas B. Osborne

FOREWORD

The outstanding contributions of Thomas Burr Osborne to the chemistry and physiology of proteins have brought honor to his name and have reflected lasting credit upon the institution he served so long and so devotedly. It seems fitting therefore that the Station should recognize his distinguished public service by some permanent testimonial of his worth. This bulletin aims to serve as a memorial of him by the colleagues with whom he labored daily, showing also something of his varied interests and activities aside from the problems of his life work, and something of those qualities which compelled the admiration of his associates and won their affection.

The committee gratefully acknowledges the courtesy of those editors who have permitted the reprinting of published articles, and desires to express its indebtedness to Miss Luva Francis who compiled the bibliography.

W. L. S.
E. H. J.
E. M. B.
H. B. V.

CONTENTS

Dr. Osborne As An Associate 281
The Work of Thomas Burr Osborne 283
Selected Papers of Dr. Osborne 291
Our Present Knowledge of Plant Proteins 291
The Chemistry of the Proteins 304
What and How Much Should We Eat? 321
Migrations of Birds 333
Thoughts on Biochemistry 339
Notes on the Nest Building Habits of the Pipe Organ Wasp 346
Honors and Memberships 348
Retirement 356
Obituaries 358
Bibliography 377

DR. OSBORNE AS AN ASSOCIATE

The facts about Dr. Osborne's inheritance, his education, his long-continued work, its great results and its final public recognition are set forth in the papers which follow. I wish to speak very briefly of some of the personal qualities of the man with whom I was associated in the Agricultural Station for more than forty years.

But it is not easy to speak soberly and without feeling of a companion and loved friend whose devotion to his work and whose dogged perseverance in meeting its difficulties I had watched almost daily for many years and in which I had shared his disappointments and his successes.

The first impression of a stranger meeting him for the discussion of things in which both were engaged would probably be that Osborne was a severe and just critic of his own work and that of others. He made it very clear that he could not accept any scientific statement unless its proof was absolutely clear to him. He hated half truths and "hedging," "for men in earnest have no time to waste in patching fig leaves for the naked truth," but kindly always. He was quick with suggestion and help to his associates, as free and judicious with praise as with criticism. His steady devotion to his work, the originality of his thought and the inspiration of his example raised the tone of the work of all who were his associates in the Station. Each of his assistants was a fellow worker, helped and encouraged by him and shown how his work was an important part of the whole research. Anxious as he was to keep his staff intact, when he saw that one was fitter for other and better paid work, he would tell him and, if he wished, help him in getting a more satisfactory place elsewhere. In times of their disability or illness he was quick to help, using his own means—sometimes largely—if that was needed.

Dr. Osborne had no taste for poetry, the drama or noble prose. He was a realist. He did not find in these things much stimulus for his imagination or charm for his leisure time. But he found both in thinking of the great problem which possessed him, a study of those things which are the basis of all physical life. It was a work which needed not only an expert chemist but a man of great originality, with clear thougbt on all the possibilities and withal a trained imagination; not "mere delectation meet for a minute's dream" but for the grasp of a vision and then strict testing of its value. He rejoiced in the discovery of a vitamin, but to see the knowledge of it saving the health and life of thousands of children in Russia was worth a lifetime. On the walls of his study hung the pictures of Liebig and Johnson, on his desk

was his wife's picture and near by on the other wall was a large diagram of a protein complex as he conceived of it, changed from time to time as his work went forward.

These were his visions. He spent forty years of his life in study and laboratory, devoted to a particular problem, putting aside tempting offers to engage in better paid work elsewhere and the other temptation to exploit his work in popular articles.

Such was his life work, but not his life, which had wider interests.

During his boyhood and youth he was greatly interested in the study of plants, insects and particularly of birds. He was a keen and accurate observer, not only recognizing their names but their nesting, feeding and migrating habits. He collected nearly one thousand specimens, some mounted, but chiefly prepared skins. In C. H. Merriam's *Catalogue of the birds of Connecticut* acknowledgment is made and there is frequent reference to the valuable contributions of T. B. Osborne. About 1880 his collecting was discontinued, as he was occupied with his chemical studies, and the specimens were given away. But his intimate knowledge of bird life remained a lifelong interest and pleasure to him. While walking with friends and discussing things of mutual interest the flutter of a small bird or a bird song would halt everything until he had seen and identified his friend and interrupter. When plagued with insomnia, as he often was, he would catch in the fall and spring the notes of migrating birds flying high at night and sometimes recognize the species. A love of nature was music and poetry to him.

His interest in the political questions of the day was keen and his knowledge of financial matters made him an active director of the Second National Bank, where he served for years.

But this is not all that specially endeared him to very many who were his intimates or were within his influence. A wholesome clean-minded man, quick, impulsive, generous and broadminded and in all ways companionable; these qualities are a large part of what made the world better for his life and our lives the poorer by his going.

EDWARD H. JENKINS.

THE WORK OF THOMAS BURR OSBORNE (1859-1929) [1]

It is given to few men to begin a scientific career with an investigation in an obscure and unattractive field, to continue their labors in it throughout a long and active life and ultimately to see this field become one of the most fertile and widely cultivated in their particular domain of science. The work of Thomas Burr Osborne on the vegetable proteins, continued from 1889 until his retirement in 1928, furnishes a striking example of a life devoted almost exclusively to scientific research upon a single group of substances and their derivatives. Owing to the diversified relationships of these substances this work has had a profound influence upon many phases of biochemistry.

Dr. Osborne was born in New Haven, Connecticut, on August 5, 1859. He was graduated from Yale University with the degree of B.A. in 1881, and received his doctorate from Yale in 1885. His dissertation was on "The Quantitative Determination of Niobium." From 1883 to 1886 he was an assistant in analytical chemistry at Yale and during this period published several papers dealing with analytical problems.

In May, 1886, at the invitation of Professor Samuel W. Johnson, professor of agricultural chemistry at Yale and director of the Connecticut Agricultural Experiment Station, Dr. Osborne became a member of the station scientific staff, forming a connection he retained until his death on January 29, 1929. Professor Johnson had become interested in Ritthausen's extensive studies of vegetable proteins. He was fully alive to their significance and suggested that further investigation was desirable. Accordingly, Dr. Osborne began in 1888 the labors that continued without interruption until his retirement.

Dr. Osborne's work on the vegetable proteins falls chronologically into three phases. From 1890 to 1901 the chief interest was in the preparation of pure specimens of the proteins of plant seeds. The initial investigation of the oat kernel, published in 1891, was followed by a series of papers in which the proteins from no less than thirty-two different seeds were described. Each of these was prepared, where possible, by a number of different methods; the criterion for purity and individuality was ultimate analysis for carbon, hydrogen, nitrogen and sulphur.

The properties of these substances were such as clearly to show the advantages, for scientific investigation, of the reserve proteins of seeds over the proteins of animal origin. Efforts to isolate proteins of definite properties from the complex mixtures in

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animal tissues had been for the most part unsuccessful, and even as late as 1911 ovalbumin was the only animal protein that had been clearly characterized as a chemical individual. On the other hand, many seed proteins were early shown by Dr. Osborne to be chemical individuals and preparations possessing identical properties were reproducible at any time.

A careful investigation was made of the proteins which had been previously grouped under the terms legumin, conglutin and vitellin, and it was shown that many of the proteins which thus had been brought together were, in fact, distinct substances. Specific designations were, therefore, in many cases coined and the use of the older names was restricted to those proteins to which they had first been applied. This clarification of the nomenclature has been of immense assistance in bringing a semblance of order into an almost hopelessly confused subject.

A few proteins had been previously prepared in crystallized form by other investigators. Dr. Osborne crystallized many of the seed globulins, and the readiness with which this could be done emphasized the fact that these proteins were definite substances entitled to the serious consideration of chemists.

The second phase of Dr. Osborne's work was initiated in 1899 with a paper[2] in which it was shown that the crystalline protein edestin from hemp seed forms two compounds with hydrochloric acid, a mono- and a di-hydrochloride, that the solubility of edestin in acid increases in direct ratio with the amount of acid present and that a number of crystallized vegetable globulins behave as bases neutralizing definite proportions of acid. In other words, the behavior of these proteins was that to be expected of basic substances of fixed composition. This was the end towards which his careful descriptive studies had been directed, a demonstration that proteins were definite chemical individuals. The position here taken was strengthened by later papers in which it was shown that proteins in general behave towards acid like bases, that they form salts both with acids and with alkalies and show many evidences of a capacity to undergo electrolytic dissociation and enter into ionic reactions.

These results emphasized the desirability of more complete chemical characterizations of the different proteins. The development of the methods of analysis of proteins at the hands of Hausmann, of Kossel and of Fischer furnished powerful means for supplying this and full advantage was taken of them. Furthermore, determinations of physical properties such as specific rotation, the heat of combustion and solubility in saline solutions contributed materially to the solution of the problem.

By 1908, when the paper on "The Different Forms of Nitrogen

[2] T. B. Osborne, *J. Am. Chem. Soc.* 21, 486 (1899).

in Proteins,"[3] perhaps Dr. Osborne's most widely quoted contribution, appeared, data had been accumulated which indicated clearly that few proteins had been obtained that could not be completely characterized by the methods of amino acid analysis, coupled with a study of the physical properties.

Beginning in 1906 and continuing for about six years, Dr. Osborne, with the aid of a number of collaborators, carried out a series of analyses of the amino acid composition of proteins by the Fischer ester distillation method. These studies set a standard for such work which has been surpassed only since the introduction in recent years of greatly improved methods for dealing with certain of the amino acids. Characteristically, he returned again and again to the analysis of a few of the proteins, such as casein, gliadin and zein, which possess special economic importance, each time increasing the summation of the components by the use of more refined technique. These analyses laid the foundation for the extensive studies of the nutritive properties of proteins that were begun in collaboration with Professor Lafayette B. Mendel, of Yale University, in 1909 and continued until 1928. This aspect of protein chemistry had attracted Dr. Osborne's interest from the earlier part of his career; but he had realized that until pure and uniform material could be obtained in abundance and its composition established by chemical analysis, an investigation of the comparative nutritive properties of proteins was useless. The striking differences which now became evident in the composition of many of the proteins suggested that their biological values might be correspondingly unlike.

It may be worth while to point out that in 1911 the notion that proteins might differ widely in nutritive value was relatively new. The chemical methods showed that wide differences in amino acid make-up occurred and, where these failed, the anaphylactogenic relationships which had been studied in collaboration with Professor H. Gideon Wells, of Chicago, emphasized the difference in all save a few remarkable cases. But where wide chemical differences occurred, as between edestin and casein, both of which were found to be adequate for growth, it became necessary to suppose that the animal organism is capable of effecting far more elaborate and extensive chemical transformations than had generally been thought.

The investigation of the nutritive properties of the proteins involved the development of a technique for feeding individual small animals which would permit accurate measurements of the food intake. This was successfully accomplished, but the first experiments in which the pure isolated proteins were fed, together with sugar, starch, lard and an inorganic salt mixture, showed

[3] T. B. Osborne, C. S. Leavenworth and C. A. Brautlecht, *Am. J. Physiol.*, 23, 180 (1908).

that normal growth of young animals did not take place, although mature animals, as well as young, could be maintained for considerable periods. Growth of young animals could readily be secured when dried whole milk powder was furnished together with starch and lard. This appeared to indicate that milk contained something other than protein essential for growth. The preliminary assumption was made that the missing factor might be supplied by the inorganic constituents of the milk, and it was found that excellent growth could be secured when evaporated milk serum, from which casein and lactalbumin had been removed, the so-called "protein-free milk," was added in sufficient amounts to a diet of isolated protein, starch and lard. With the assistance of this material an extensive investigation revealed wide differences in the alimentation of animals on different proteins. Animals rapidly failed on zein and gelatin, were maintained on hordein, rye and wheat gliadin but grew well on edestin, wheat glutenin, lactalbumin or casein. Further work showed that the failure of animals on a zein diet was due to the lack of tryptophane and lysine in this protein. When these amino acids were supplied growth occurred. Similarly, gliadin could be made adequate for growth by an addition of lysine in which this protein was conspicuously deficient.

The use of protein-free milk in diets was attended by certain difficulties. It is not entirely free from nitrogen and it could not be successfully replaced by an artificial mixture of salts made to imitate the composition of milk ash as closely as possible. Furthermore, animals nourished on this diet over long periods ultimately ceased to grow and declined rapidly in weight. In every case such animals could be brought to a normal rate of growth by changing to a diet containing whole milk powder, and the ultimate failure on protein-free milk could be postponed or averted by feeding whole milk powder for occasional short intervals. An examination of the composition of the two types of food revealed that the most conspicuous difference lay in the presence of milk fat in the dried milk food. Experiment soon showed that the addition of butter to a casein, starch and protein-free milk diet sufficed to permit normal growth to maturity. When butter was added to a diet of dried skim milk upon which it had been found that animals ultimately failed, complete realimentation occurred.

These results were published in 1913. The paper describing them was submitted to the *Journal of Biological Chemistry* about three weeks after a paper by McCollum and Davis in which similar results secured by the use of an ether extract of egg yolk and of butter, were described. The observations indicated that a substance occurs in butter which is essential for animal growth. This substance was later designated as vitamin A.

In the following year the important observation was made that the same stimulation of growth could be secured by the addition of cod-liver oil to a diet of purified food substances and protein-free milk, a discovery which served to focus attention upon the value of this oil, in particular as a curative agent for the peculiar eye condition known as xerophthalmia that was regularly encountered by Osborne and Mendel in animals on the deficient diets. At the close of the war the sight of many children in Europe was preserved by its use, a remarkable example of the application of scientific results to practical problems.

The later extensive contributions of Dr. Osborne and his associates to the science of nutrition can only be indicated. Much labor was devoted to the study of the nutritive value of the proteins of the commercially important foods and this work gave a rational explanation of many practices which empirical experience had shown to be advantageous. The distribution of vitamins A and B in natural food products was studied and considerable success was attained in an effort to prepare a vitamin rich concentrate from yeast. The phenomena of growth, its suppression and acceleration under various regimens, the effect of the individual inorganic constituents of the diet, these and many other topics received attention at different times.

The remarkable influence of minute traces of certain organic substances, the presence or absence of which in the diet determine success or failure of nutrition, drew attention to the importance of an investigation of the constituents of living cells. This led to a detailed study of extracts of the alfalfa plant and of yeast, both of which are valuable sources of vitamins. Much of the information secured did not reach the stage of publication, but a striking demonstration was obtained of the complexity of the chemical environment in which the life process takes place.

It would be incorrect to assume that Dr. Osborne's interest in the fundamental chemistry of proteins waned as he penetrated more deeply into the mysteries of animal nutrition. Innumerable chemical problems arose as a result of the feeding work and demanded solution. Such, for example, was the discovery in 1913 of lysine among the products of hydrolysis of gliadin: its presence had escaped the notice of previous observers, including himself. A study of the constituents of milk in 1917 revealed a new protein soluble in diluted alcohol, the first animal protein possessing this property to be found. Its anaphylactogenic relationships were worked out in collaboration with Professor Wells in 1921, and it was demonstrated to be distinct from the other three proteins of milk.

Dr. Osborne made a fundamental contribution to the chemistry of nucleic acids in 1900, when he announced the discovery of tritico-nucleic acid in the wheat embryo and observed that this

substance yielded the purines, guanine and adenine, in molecular proportions. Subsequently he made it clear that the various nucleoproteins which could be prepared from the wheat embryo were in reality salt-like compounds of one and the same protein with variable proportions of nucleic acid. Generalizing from these observations he pointed out that the numerous nucleoproteins from animal sources that had been described were, very probably, also salt-like compounds of protein with nucleic acid.

Although all the preparation work and much of the chemical investigation of the proteins was done before the modern conceptions of acidity had been advanced, Dr. Osborne was aware of the influence of different degrees of acidity on his preparations. One of his early papers on the effect of small amounts of acid on edestin[4] contains the phrase "the concentration of the hydrogen ions in the solution," and it was his custom invariably to state the indicator which he used. It was not sufficient to neutralize a solution; the solution was neutralized to phenolphthalein, or litmus, or tropeolin, as the case might be, and the differences in behavior so indicated were fully appreciated. It is this meticulous attention to detail which gives Dr. Osborne's early work a value to the present-day physical chemist and renders it possible to furnish an interpretation in terms of modern theory, as has recently been done by Cohn.

Dr. Osborne was one of the most distinguished pupils of Professor S. W. Johnson, and through him traced his intellectual ancestry back to Liebig, the founder of agricultural chemistry. A painstaking, careful investigator who spared no effort, time or expense in the attainment of the truth, Dr. Osborne accepted no result until it had been subjected to the test of rigorous and repeated experiment and all his publications bear the marks of meticulous editing, lest a statement should to the slightest extent pass the bounds of ascertained fact.

To those who were privileged to be associated with him in his work he was a rare stimulus, a formidable opponent in argument and an ever genial but just critic. He frequently closed a discussion with the remark that facts were to be found in the laboratory, not in the books. Naturally shy and retiring, the delivery of a public address or of a paper was a severe trial to which he looked forward with trepidation. But among a small group of friends he showed himself as a gifted conversationalist, who was equally able to discuss the latest achievements of science, the current political situation, the intricacies of the world of finance or the faults of the modern educational system.

The first public recognition of Dr. Osborne's exhaustive work came from Germany. V. Griessmayer, in 1897, published a book

[4] T. B. Osborne, *Z. physiol. Chem.*, 33, 225 (1901).

on vegetable proteins that contained many extracts from Dr. Osborne's papers and stated in the introduction that it was his object "to bring to light these treasures buried in their American publications." This encouragement at a time when few of his associates or scientific friends had any conception of what his work meant, was of great assistance to him.

In 1900 he was awarded a gold medal by the Paris Exposition. In 1910 recognition came from Yale University in the form of the honorary degree of Sc.D., and in the same year he was elected a member of the National Academy of Sciences. Two years later he was made an honorary fellow of the London Chemical Society, and in 1914 he was made a fellow of the American Academy of Arts and Sciences.

In 1922 he received the John Scott medal and in the following year was made a research associate in biochemistry of Yale University with professorial rank. In 1928 he was the first to receive the Thomas Burr Osborne gold medal founded by the American Association of Cereal Chemists in recognition of his outstanding contributions to cereal chemistry.

Dr. Osborne's extensive investigations would have been impossible without generous financial support and encouragement. Throughout the early years, when results came slowly and their application was by no means apparent, the directors of the Connecticut Agricultural Experiment Station, in the early years Professor S. W. Johnson, and after 1900, Dr. E. H. Jenkins, with the coöperation of an enlightened board of control, allowed no interference or distraction to hinder the progress of the work. Since 1904 a large proportion of the financial burden has been borne by the Carnegie Institution of Washington, D. C., of which he was a research associate. Dr. Osborne's connections with both the experiment station and the Carnegie Institution of Washington furnish a striking example of the value to science of a policy of non-interference on the part of those in control of the distribution of funds for research. Except for routine annual reports he was never asked for statements of progress or for outlines of projects. The relationship was always one of the utmost mutual confidence and esteem.

The results of Dr. Osborne's investigations were summarized in a monograph, "The Vegetable Proteins," which first appeared in 1909 and was extensively revised in 1924. This slim volume has become the classical publication in the field. His extensive studies of wheat proteins were reviewed in "The Proteins of the Wheat Kernel" (1907), now a standard text among cereal chemists. Including these and a few public addresses and popular articles a complete bibliography of his publications reaches 253 titles, of which about two hundred are journal reports of his personal scientific work.

Dr. Osborne's most marked characteristic was, perhaps, the thoroughness with which his problems were investigated. In the early preparation work each protein was isolated in as many different ways as possible, the composition finally ascribed to it was deduced from a large number of carefully conducted analyses and, where the economic importance of the protein warranted it, he returned again and again to its study. The wheat and maize prolamins received extraordinary attention and the methods of preparing even these well-known substances were recently, with the aid of his assistants, materially improved. Time and again he discarded the whole of his painfully acquired results to make a fresh start, this time to "do it right," as he expressed it. His death removes one of the great pioneers of American biochemistry, a man whose name will always be linked with the subject he made peculiarly his own. He was more fortunate than most men in that advancing years, distinctions and scientific recognition did not bring with them administrative responsibilities that deprived him of the opportunity to share in the daily work of the laboratory. His time was always freely available for discussion, not only with his associates, but with the innumerable investigators from all parts of the world who came to New Haven to see him and ask for advice. Ever kindly and courteous, with keen insight into the problems of others and an extraordinary wealth of experience upon which to form his judgments, he has left a memory that will long be treasured by those who had the privilege of knowing him.

HUBERT B. VICKERY,
LAFAYETTE B. MENDEL.

SELECTED PAPERS OF DR. OSBORNE

OUR PRESENT KNOWLEDGE OF PLANT PROTEINS[1]

To the biological chemist few substances present so many features of interest as the proteins of plants. These lie at the very foundation of the nutrition not only of plants but of animals, and from them are derived a multitude of products directly connected with physiological processes. The study of chemistry of plant proteins, although it early interested several of the leading chemists of their time, has received in the aggregate so little attention that to-day our knowledge of this subject is but slightly advanced beyond what may properly be called a beginning. How slow the progress has been may be shown by a brief review of the literature that is on record.

HISTORICAL

In 1746, Beccari announced his discovery of a peculiar substance which he obtained by washing wheat flour with water, that had all the properties which up to that time had been considered to be characteristic of animal life only. This substance, which we now know to be wheat gluten, appears to have been for more than fifty years the only form of vegetable protein that was known, for Beccari failed to obtain similar products from other seeds. In 1805, Einhof discovered that a part of the gluten of wheat was soluble in alcohol, and he described the existence of similar proteins in rye and barley. Einhof overlooked the fact that only a part of the gluten of wheat was dissolved by alcobol, and he considered this property to be characteristic of all plant proteins except the "Eiweiss," which he obtained by heating the aqueous extracts of seeds and other parts of plants. When, therefore, he later discovered in leguminous seeds another form of protein which was not soluble in alcohol, but had in pronounced degree the properties of "animal matter," he assumed that he had obtained a substance belonging to a distinctly different group but yet related to the gluten or "Kleber" that had been found in other seeds.

Taddei, in 1820, showed that only a part of the wheat gluten was soluble in alcohol and he applied distinctive names to each part; gliadin to the substance soluble, and zymom to that insoluble, in alcohol.

From this time chemists were more and more attracted to the

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[1] An address delivered before the American Chemical Society at New Haven, Conn., July 1, 1908. Reprinted from *Science*. 28. 417 (1908) by permission of the editor.

study of vegetable proteins, and among those thus engaged are found many of the most distinguished chemists of the earlier part of the last century, such as Berzelius, Dumas, De Saussure, Boussingault, Liebig and many of his pupils.

In 1841, Liebig reviewed the work done in his and other laboratories on the properties and composition of plant proteins. The state of knowledge which then prevailed respecting this subject is well illustrated by the following quotation from his review:

> Another, in number very limited, class of nitrogenous compounds is very abundantly distributed. There are four of these substances, of which one occurs, without exception, in all plants, while the others are only constituents of certain families of plants. These are the nitrogenous food substances properly known under the names of Vegetable "Eiweiss," Pflanzenleim and legumin. . . . These substances, to which a fourth must be added, which I will name Pflanzenfibrin, are the true food substances of the plant-eating *animals.*

In discussing these four proteins, Liebig asserted that each was identical with the protein of animal origin bearing the corresponding name. The identity of legumin with milk casein was claimed and this protein he therefore named plant casein.

The work undertaken by Liebig was continued for twenty years or more by Ritthausen, who was one of his pupils. Ritthausen, in 1860, began the first serious study of these important substances and devoted much time and care to the production of preparations of the highest attainable purity, and to accurate determinations of their ultimate composition. His work greatly extended the scope of the prevailing knowledge of the plant proteins, and made it plain that these substances exist in much more diverse forms than had before been supposed. He also added much to our knowledge of the decomposition products of vegetable proteins by showing that they yielded many substances already obtained from proteins of animal origin, and discovered glutaminic acid which is now recognized as a constitutent of practically all proteins, whatever their origin. He was also the first to obtain aspartic acid from the products of protein hydrolysis.

In 1877 Hoppe-Seyler and his pupil Weyl applied to seeds the then recently developed method of extraction by solutions of neutral salts. They showed that a large part of the protein of a number of different seeds was soluble in such solutions, and had the properties of the so-called globulins of animal origin. While the experimental work of these investigators was hardly more than qualitative and of very superficial character, the conclusions which they drew and the criticisms of Ritthausen's work which they put forth were generally accepted as final by most physiologists, and threw it into general discredit.

Although Ritthausen afterwards showed that a large part of many of his previously described preparations, which had been

obtained by extraction with dilute alkalies, was soluble in solutions of neutral salts, and that the composition of many of the proteins which he had previously analyzed was the same as that of preparations obtained by extraction with solutions of sodium chloride, nevertheless physiologists continued to repeat the criticisms of Hoppe-Seyler, and the work of Ritthausen failed to receive the recognition which it deserved.

REVIEW OF THE WRITER'S WORK

Since Ritthausen ceased his work with vegetable proteins little has been done in this field outside of my own laboratory. It is true that from time to time papers have appeared dealing with special questions in the chemistry of these substances, but no other connected and extensive investigation has been described, and as the work which I have been doing during the past twenty years has now reached a point where it can be profitably reviewed, I propose to take up some of its more important features and briefly discuss them.

As Ritthausen's researches were far from exhaustive and left the subject in such a state of confusion that it was impossible to form definite conclusions respecting much that he had described, it seemed best to me to direct attention chiefly to those seeds which had been previously studied by him and by others, and to try to clear up the existing uncertainties, rather than to add to them by describing new proteins. As a result, we now have about twenty-five different proteins of vegetable origin, the important characters of most of which have been studied by all means at present available. These proteins appear to represent the different types to be found in seeds and are, I think, sufficient in number to form a suitable foundation for the future study of their chemistry. All of these are constituents of seeds. A few of them represent constituents of the physiologically active embryo, but the majority represent the reserve food protein of the endosperm, and serve not only for the nutrition of the growing seedling, but also for the nutrition of men and animals. Of the protein constituents of other parts of plants very little indeed is known.

CHEMICAL INDIVIDUALITY OF PROTEINS

In considering the position of our present knowledge of the seed proteins, the question of chemical individuality should first be considered. We are now well past the time when agreement in solubility, ultimate composition and color reactions, are to be accepted as evidence of the identity of two preparations of protein. It is not necessary to explain why it is at present not possible to demonstrate the chemical individuality of any single protein, for the reasons are evident to all who will give this question the

slightest consideration from the standpoint of the organic chemist. While it is not possible to establish the individuality of any protein, it is possible to show differences between the various forms which can be isolated, and to establish a constancy of properties and ultimate composition between successive fractional precipitations which give no reason for believing the substance to be a mixture of two or more individuals.

On the basis that agreement in ultimate composition affords no evidence of identity of two similar proteins, but that distinct and constant differences in composition are conclusive evidence that they are not alike, I have endeavored to differentiate the several seed proteins that I have studied, and have since subjected them to careful comparisons in respect to their physical properties and the proportion of their decomposition products, so that those which are alike in their more apparent characters have been still further distinguished from one another. Whether these are in fact chemical individuals, must await the development of new methods of study. For the present they must be accepted as the simplest units with which we can deal.

SUITABILITY OF SEED PROTEINS FOR A STUDY OF PROTEIN CHEMISTRY

The various proteins thus established furnish material for further study, and are characterized by wide differences not only in physical properties, but in the proportion of their decomposition products. They can be prepared in large quantity in a high state of purity, and, being a part of the reserve food stored up for the nutrition of the developing embryo, are by nature more stable than the animal proteins which form a part of physiologically active tissues. Furthermore, they are not associated with tissues and fluids rich in other forms of protein from which they are to be separated, and they are mostly obtained in the form of dense precipitates, often crystalline, which are little inclined to adsorb other substances from which they can afterwards be separated with difficulty. Although associated intimately in the seed with many forms of soluble and insoluble carbohydrates, they can, in many cases, be separated from every trace of the latter, as is shown by appropriate reactions.

It is my firm belief that a careful examination of them will ultimately afford a better knowledge of the chemistry of proteins in general than can be obtained from proteins of animal origin. Although the problems immediately connected with the animal proteins are of greater importance to physiology than those at present recognized as connected with seed proteins, there is no question but that definite knowledge of the chemistry of seed proteins will be directly applicable to many important problems of animal physiology.

THE DIFFERENT GROUPS OF PROTEINS FOUND IN SEEDS

The seed proteins for the most part can be grouped in much the same way as the proteins of animal origin, but in so doing, it is necessary to modify to some extent the requirements to which the animal proteins belonging to some of these groups are at present assumed to conform. The necessity of some scheme of classification for the proteins is recognized by all who write or teach about them, and although the present method of classifying proteins according to their solubility is wholly unsatisfactory from a purely chemical standpoint, it is practically the only one now available. On chemical grounds there is no more reason for dividing the proteins into two groups of animal and vegetable proteins, than there is for making a similar distinction between the carbohydrates. I have, therefore, endeavored to assign the various forms of seed proteins to the commonly recognized groups established for those of animal origin, and have proposed to slightly modify the definitions usually given for these groups, but only so far as this is necessary.

1. *Globulins* form much the greater part of the reserve protein of all seeds except those of the cereals. By globulin is meant protein soluble in solutions of neutral salts but insoluble in water. This definition does not strictly apply to many of the seed proteins assigned to this group, for these behave as globulins only under certain conditions. As these conditions prevail during the extraction and isolation of these proteins and depend on the presence of free acid in the extracts, it is important to consider the relations of the proteins to this acid.

The behavior of seed globulins toward acid is shown by studies made in my laboratory on edestin. Crystallized preparations of edestin, obtained by dialyzing or cooling sodium chloride extracts of hemp-seed, frequently contain protein in three forms; one, soluble in pure water and also in strong saline solutions, another, insoluble in water but soluble in strong saline solutions, and still another, insoluble either in water or in saline solutions. The proportion of these products varies with slight differences in the conditions under which the edestin is isolated, and plainly depends upon changes in the protein which take place during its preparation.

The explanation of these changes has been found in the presence of a small amount of acid extracted from the seed together with the protein. The part of the edestin preparation just referred to, which is insoluble in neutral saline solutions, has been found to be a product of the hydrolytic action of the acids of the extracts. This product is not the result of a profound splitting of the edestin molecule, for the changes leading to its formation are so slight that they can be detected only by the altered solubility. For such primary products of protein hydrolysis, which were designated "albuminates" by Weyl, I have proposed the name "protean" and for the products derived from the individual proteins, a

corresponding name ending with the affix *an*. Thus the product derived from edestin may be called *edestan*. The part of the edestin above referred to which is soluble in water contains more combined acid than the part insoluble therein. The preparation, therefore, contains a mixture of salts of edestin. These edestin salts contain some of all the anions present in the solution at the time of precipitation, that salt being predominant whose free anion was most abundant in the solution from which the edestin was last precipitated. When freed from this combined acid by making the preparation neutral to phenolphthalein, the edestin is wholly insoluble in water, but soluble in neutral saline solutions. Edestin has, consequently, the properties of a true globulin. Other seed proteins behave towards acids in a similar way, except that some of them, when neutral to phenolphthalein, are soluble in water. Many of these latter behave as globulins when in the form of salts, and as they are obtained as salts by the methods employed in preparing them, I have, for convenience, placed them among the globulins.

The fact that our protein preparations, as usually obtained, are protein salts is fundamental for a correct conception of their behavior under the conditions of isolation and purification, and for an explanation of many of their physiological relations.

The seed proteins which are described as globulins differ in some of their properties from some of those that are commonly assumed to characterize the globulins of animal origin. In this connection, however, the fact should not be overlooked that our knowledge of animal globulins is relatively small, and it is probable that further study will modify our present conception of them. It has become customary for physiologists to consider that all *globulins* are precipitated by adding to their solutions an equal volume of a saturated solution of ammonium sulphate, and of recent years it appears to have become an almost universal practise to designate as globulin all of the protein that can be thus precipitated. This practise is unfortunate and leads to confusion, for it wholly ignores the original conception of a globulin, namely, a protein soluble in neutral saline solutions but insoluble in water.

Globulins are commonly described as proteins that are coagulated by heat. This is doubtless true of the globulins of seeds if sufficient acid is present in their solutions. It is, however, difficult to add to the saline solutions of most seed globulins a sufficient amount of acid to cause complete coagulation on heating, for even a very minute quantity of acid in a strong saline solution alone precipitates a large quantity of the globulin.

The deportment of edestin in this respect is well illustrated by the experiments of Chittenden and Mendel,[2] who showed that a saline solution of edestin was only partly coagulated by boiling,

[2] Chittenden and Mendel, *J. Physiol.*, 17, 48 (1894).

that the edestin remaining in solution could be recovered unchanged and in well-formed crystals, and that addition of acid to the solution filtered from the coagulum gave rise to a new coagulum on again heating.

2. *Prolamins*[3] form a unique and sharply differentiated group of proteins which occur in quantity in the seeds of cereals, but not in those of any other plant yet examined. These are soluble in all proportions in alcohol of 70-80 per cent., and are not affected by boiling their alcoholic solutions, even for a long time. They are practically insoluble in water and saline solutions, but are soluble in dilute solutions of acids and alkalis.

The prolamins are better characterized, from a chemical standpoint, than any of the other groups of seed proteins, for on hydrolysis they all yield a very small amount of arginine and histidine and no lysine whatever. On the other hand, they yield from 20 to 30 per cent. of their total nitrogen in the form of ammonia and also contain relatively large amounts of glutaminic acid. Gliadin from wheat and rye, and the related hordein from barley, yield about 37 per cent. of glutaminic acid, which is very much more than that found in any other protein yet examined, and zein yields nearly 20 per cent., which places it among the proteins relatively rich in this amino-acid.

Prolamins have been found in the seeds of all the cereals examined in my laboratory, namely—oats, wheat, maize, rye, barley and sorghum. That this form of protein is characteristic of the seeds of all grasses is rendered improbable by the recent report of Rosenheim and Kajiura,[4] who found none in rice. A detailed statement of their results, however, has not, to my knowledge, yet been published.

3. *Glutelins* constitute a large part of the proteins of all cereals that have been studied, and possibly occur in seeds of other kinds. These proteins are insoluble in all known neutral solvents, but are easily dissolved by very dilute acids or alkalis. Only one member of this group is known which is accessible to satisfactory investigation. This is the glutenin of wheat which forms nearly one-half of the gluten. Owing to the fact that glutenin can be separated from the other components of the seed as a constituent of the gluten, it is possible to make preparations of it of a fair degree of purity.

As the seeds of the other cereals yield no coherent gluten, the

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[3] I propose this name for the group which heretofore has been simply called alcohol-soluble proteins. The name refers to the relatively large proportion of proline and amide nitrogen which they yield on hydrolysis. The English committee on protein nomenclature has very recently proposed to call these proteins gliadins, but as this name has long been used to specifically designate the prolamin obtained from wheat it seems to me important to have a distinctive name for this group.

[4] Rosenheim and Kajiura, *J. Physiol.*, **36**, liv (1903).

protein corresponding to glutenin can not be isolated from them, for the alkaline extracts of these seeds are too gummy to filter and the small amount of the preparations that can be obtained is very impure.

Whether glutelins are constituents of other seeds is a question not yet settled. Most seeds, when exhausted with the several neutral solvents, still contain a small amount of protein which can be extracted with alkaline solutions. It has not yet been definitely determined whether these products are residues of the other proteins extracted by the neutral solvents, or are actually different substances. It is quite conceivable that a part of these other proteins may form combinations with other constituents of the seeds which are not soluble in neutral solvents but are extracted by alkalies, and also that a part of the protein is enclosed in tissues which are dissolved by the alkali and the protein then brought into solution. It is also possible that much or all of this protein is the result of a change, whereby a part of the protein originally soluble in neutral solvents is converted into less soluble products, such as those which have been designated as proteans. The quantity of nitrogen which remains in the thoroughly extracted residues of the seeds is small in the case of most seeds other than the cereals, and it is not probable that many of these contain much, if any, protein belonging to the glutelin group.

4. *Albumins* are probably present in *very* small amount in nearly all seeds, and in none of those that I have examined are they present in large amount. The albumin is probably a part of the physiologically active embryo, and resembles the proteins of animal origin in properties, ultimate composition and proportion of the various products of hydrolysis, more closely than do most of the reserve proteins of the endosperm. While the albumins of seeds are like those obtained from animals in the essential properties of solubility in water and coagulability by heat, they differ in their precipitation relations towards strong solutions of inorganic salts.

It is at present almost universally assumed that albumins are not precipitated by adding to their solutions an equal volume of a saturated solution of ammonium sulphate, but this is not the case with all of the albumins from seeds. Many of them are also precipitated by saturating their solutions with sodium chloride or with magnesium sulphate, in which respect they differ from animal albumins.

5. *Proteoses* similar to those of animal origin have been obtained from all the seeds examined, and from some, proteoses closely resembling hetero-, deutero- and proto-proteose were separated. The amount of such proteose is small in all the seeds which have come under my observation, and it is possible that all of this is formed by enzyme action during isolation of the other proteins of the seeds.

There are several groups of proteins which occur in animal tissues, which have not yet been proved to exist in plants. The most important of these are those which contain phosphorus. In the yolk of eggs and in the milk of mammals, a large part of the protein which nourishes the developing animal contains phosphorus which appears to be intimately concerned in the structure of its molecule. No similar phosphorus-containing proteins have been found in seeds, although by analogy such might be expected to occur. It has been asserted that such proteins are found in leguminous seeds, but an examination of the literature will show this assertion to be founded on very little experimental evidence. Czapek, in his "Biochemistry of Plants," describes the proteins of seeds as vitellins which doubtless contain phosphorus. This view, however, has no evidence to support it and is quite incorrect.

The existence of nucleoproteins, that is of compounds of nucleic acid with protein, is a different question and involves consideration of the chemical nature of these substances as now described. The nucleoproteins are, as far as I know, always described as phosphorus-containing proteins, and the phosphorus seems to be generally considered as a constituent of their molecules. This, of course, is strictly true even if the combination be only that of a base and an acid, but from the standpoint of protein chemistry it makes a great deal of difference whether this union is that of a salt, or one in which the phosphorus-containing groups are in intimate organic combination within the protein molecule. That true nucleic acids exist abundantly in seeds has been demonstrated by investigations made in my laboratory on the wheat embryo. In these investigations a great deal of attention was devoted to the protein compounds of the nucleic acid, but all the evidence obtained indicated very plainly that these were simply protein nucleates, the composition of which depended solely on the conditions prevailing at the time of precipitation. That *similar* combinations exist within the embryo is practically certain, but that any of the combinations actually isolated were *identical* with the combinations that exist in the seed, I consider highly improbable. Whether the nucleoproteins that have been described from animal tissues are more definite and intimate combinations between the nucleic acid and the protein than are the protein nucleates just mentioned, I am not prepared to say, but I think that nucleoproteins deserve more consideration from this point of view than they have received.

Whether, or not, true glycoproteins are contained in seeds, remains to be demonstrated. That a large part of the seed proteins are entirely free from any carbohydrate yielding group, is proved conclusively by the fact that these yield no trace of the Molisch reaction. That those that give the Molisch reaction contain a carbohydrate group as a constituent of their molecule is

seriously to be questioned, for it is not possible to obtain even traces of furfurol from them.

If one considers how small an admixture of carbohydrate gives a very strong reaction with the Molisch test, it may well be asked whether this reaction is not sometimes caused by a slight contamination. The possibility of this is so great in the preparations of proteins extracted from seeds containing a great variety of carbohydrates, glucosides and nucleic acids, that conclusions drawn from the results of the Molisch reaction have value only when this turns out negatively.

In plants no representative has yet been found of the group of albuminoids which form in animals so large a part of the skeleton, connective tissues, the skin and its appendages.

Although the nucleated cells of the wheat embryo are rich in nucleic acid which closely resembles in its properties and structure the nucleic acids obtained from the nucleated cells of animals, no substances have yet been found in plants which resemble the protamines which, in combination with nucleic acid, occur so abundantly in the spermatozoa cells of animals. Such substances are to be sought in the pollen cells of plants, but as yet no attempt has been made to isolate them, owing to the difficulty of obtaining a sufficient supply of material, and the fact that the nucleus of the cell forms so small a part of the whole structure.

PRODUCTS OF HYDROLYSIS OF SEED PROTEINS

Of the known primary products of protein hydrolysis all but one (diamino-trioxydodecanic acid, as yet obtained only from casein) have been isolated from seed proteins, and there is no indication that any essential difference exists in the general character of the structure of the proteins from these two forms of life. Some of the seed proteins, like some of those from animals, lack one or more of the amino-acids; and zein, from maize, lacks glycocoll, tryptophane and lysine. The crystalline globulins, which are possibly more definite chemical individuals, have yielded on hydrolysis as complicated a mixture of amino-acids as any of the amorphous preparations. These, therefore, furnish no ground for the assumption that the several proteins, as we now know them, are mixtures of less complex substances.

Of twenty-three different seed proteins which have been hydrolyzed, all have yielded leucine, proline, phenylalanine, aspartic acid, glutaminic acid, tyrosine, histidine, arginine and ammonia. Five have yielded no glycocoll. Two yielded no alanine which could be positively identified, but did yield impure products which left little doubt but that this amino-acid was present. Four yielded no lysine, and one, no tryptophane. Four of these proteins yielded extremely small quantities of cystine, three others, none. The

remaining sixteen have not yet been examined for this amino-acid on account of the difficulties encountered in separating small quantities of it. No attempt has yet been made to isolate isoleucine. If this amino-acid is yielded by the seed proteins it will probably be found in the mixture of undetermined substances from the third fraction of the esters, which has not been converted into products suitable to weigh. Glycocoll, lysine and tryptophane are the only amino-acids that have been proved lacking in any one of these proteins.

In respect to the quantitative relations of the amino-acids, the fact must not be overlooked that the determinations of many of them are to be regarded only as approximations to the amounts actually yielded by the protein. The determinations of the mon-amino-acids by Fischer's method are doubtless comparable within certain limits, if sufficient care is exercised in conducting the analysis. The quantities of these amino-acids recovered are unquestionably less than those actually present, for esterification is never complete and the losses incident to the separations by fractional crystallization are not inconsiderable. Under uniform conditions, however, losses are nearly uniform and the figures representing the quantities of amino-acids found give a good idea of differences and similarities between the different proteins. Such figures are in most cases comparable to within perhaps one per cent. of the protein, and probably represent about seventy-five per cent. of the total quantity of the amino-acids which are determined that were originally formed by hydrolysis, providing that these amino-acids are first subjected to two well-conducted esterifications. Most uncertainty attaches to the results obtained for valine and serine, which are separated from associated substances with such difficulty that the determinations of them must be regarded as simply qualitative. Alanine also is difficult to separate in a condition fit for weighing, and no importance is to be attached to differences in the amount of this amino-acid unless these are pronounced.

A very extensive experience, however, with determinations, of arginine, histidine and lysine has convinced me that it is possible to make quantitative determinations of these bases which are very accurate. The results of these determinations can be controlled by comparing the amount of nitrogen contained in the quantities found with that precipitated by phosphotungstic acid under definite conditions which have been worked out in my laboratory. The amount of ammonia yielded by hydrolysis can be determined with such accuracy that differences of only a very few hundredths of a per cent. occur between determinations made on different preparations of one and the same protein. These four determinations are the most reliable that we now have for comparing proteins

with one another, and make it possible to detect differences between them which would otherwise escape notice.

Glutaminic acid can be determined in most cases with a close approximation to its true amount, but there are some proteins, especially those from leguminous seeds, from which it is not easily obtained. Experience has shown that by the ester method alone about seventy-five per cent. as much glutaminic acid is usually obtained as by direct separation as the hydrochloride. It is possible, therefore, to control to a certain extent the results of direct determinations by comparing them with those obtained on a larger scale by the ester method.

Although the methods available for thus quantitatively analyzing the products of protein hydrolysis leave much to be desired, it must not be forgotten that only recently have we been able to make any comparison whatever of the proportion of these products.

A striking feature of these analyses, to which Professor Chittenden directed attention in his address before this society last January, is that the total quantity of the substances determined falls far short of one hundred per cent. The majority of successful analyses foot up between sixty and seventy per cent., and of this a part is made up of water which has been introduced by hydrolysis. Calculation shows this amount of water to be approximately equivalent to the losses that may be assumed to occur through incomplete esterification and separation of the acids, so that the summation of well-conducted analyses may be taken as representing somewhere near the total quantity made up by all the different substances determined.

Nothing is known of the undetermined residue which forms from twenty-five to thirty-five per cent. of the protein. There is no reason to believe that, in the seed proteins, undetermined carbohydrate forms any part of this, for those proteins which give no Molisch reaction give no higher summation than do those that do.

If the amount of nitrogen contained in the quantities of the amino-acids stated in the analyses is subtracted from the total nitrogen of the proteiu, it is found that this undetermined nitrogen forms about fourteen per cent. of the undetermined part of the protein. This is a higher proportion of nitrogen than is found in any of the monamino-acids that are known to be yielded by proteins, except glycocoll, alanine, serine and tryptophane, even if the proportion of nitrogen is calculated for them as united with one another in polypeptide union. It is improbable that this undetermined residue is made up of these four amino-acids, and we may expect to find still undiscovered substances among the protein decomposition products.

COMPARISON OF THE PROTEINS OF DIFFERENT SEEDS

The results of this comparative study of the seed proteins shows that no two seeds are alike in respect to their protein constituents. Similar proteins are found only in seeds that are botanically closely related.

The cereals are alike in the proportion and general character of their proteins. The seeds of each of these, with the probable exception of those of rice, contain a small amount of proteose, albumin and globulin, and relatively considerable quantities of prolamin soluble in alcohol, and of glutelin insoluble in neutral solvents. With the exception of the nearly related wheat and rye, the proteins soluble in alcohol from each of the cereals are distinct substances. Although no certain difference has yet been detected between the gliadin of wheat and of rye, their glutelins are not alike.

The leguminous seeds are similar in the general character of their proteins, but marked differences exist between the proteins of the various groups. Thus *Lupinus, Vicia* and *Phaseolus* present marked differences in their proteins, whereas the proteins of the species of each genus are very much alike. The proteins of *Lupinus luteus* and of *Lupinus angustifolia* differ slightly but in their physical properties are clearly distinguished from any of the other seed proteins. Although similar proteins are obtained from the horse bean, lentil, pea and vetch, these are distinctly different from the proteins obtained from other leguminous seeds. These seeds are not alike, however, in the proportion of their several proteins. The chief protein of *Phaseolus vulgaris* appears to be identical witb that of *Phaseolus radiatus,* but the small amount of other protein was found to be different in properties and composition in each of these seeds.

The cow pea (*Vigna*) and soy bean (*Glycine*) contain distinctly different proteins which, however, are similar to but different from those of *Vicia.* The globulins of the seeds of *Corylus* and *Juglans* are much alike, but not identical, while those from *Juglans regia, nigra* and *cinerea,* so far as they have been compared, show no differences. The proteins of other seeds show marked differences, but the botanical relations of these seeds are not such as to permit of furtber discussion of tbis subject.

Although the data for generalizations are as yet few, those that are available plainly indicate a close connection between the chemical constitution of the seed proteins and the biological relations of the plants producing them.

That similar differences exist between homologous proteins of different species of animals is becoming evident from the facts which are gradually accumulating, and these strongly suggest a chemical basis for the multitude of diverse forms of animal and vegetable life.

THE CHEMISTRY OF THE PROTEINS[1]

The recent advances made in our knowledge of the chemistry of the proteins have attracted wide attention and excited much interest on account of the important connection which they have with many of the fundamental problems of physiology and biochemistry. These newer discoveries have been the subject of many excellent reviews and are now familiar to most of those who are interested in the various branches of biology. On the other hand, there are aspects of protein chemistry which have received but little notice during recent years, although they have an important bearing on the application of these discoveries to physiological problems. These seem well worth bringing before you this evening.

Attention has of late been largely centred on the salient features of the constitution of the proteins as revealed by the brilliant work of Fischer and of Kossel, and many elaborate attempts have been made to apply the ideas suggested by their discoveries. These have at last given us a conception of the constitution of these substances which, while far from complete, has been of the greatest help in dealing with chemical and physiological problems in which the proteins are involved.

The two most important of these new discoveries in protein chemistry are that the proteins consist essentially of combinations of amino-acids joined with each other by a union between the carboxyl group of one with the amino group of another, and that many of the various forms of protein differ widely in their constitution. That the proteins are composed, at least in large part, of combinations of amino-acids can be accepted as proved by the fact that the only substances which have been isolated from the products of their complete decomposition are amino-acids, and a small proportion of ammonia. That these amino-acids are united in the way just stated is proved by the presence among the products of partial hydrolysis of combinations of amino-acids which are identical with synthetic products of known constitution. Whether those amino-acids which are now obtained from the proteins are their only constituents is still undetermined, for in no case, if we except one or two of the protamines, have the recovered products of hydrolysis been even approximately equal to the amount of protein which yielded them. All who are familiar with the methods employed in making these analyses have regarded the values obtained for many of the amino-acids as minimal, but some of these, as, for instance, those for glutaminic

[1] A lecture delivered February 4, 1911, before the Harvey Society and reprinted with the permission of the J. B. Lippincott Company, Philadelphia, publishers of the Harvey Lectures, and of the secretary of the Harvey Society.

acid and tyrosine, have been considered, notably by Abderhalden,[3] as approximately correct. So long as much of the protein cannot be accounted for in products of definite character, uncertainty will prevail as to whether many of the apparent differences between the individual proteins are in fact real or only due to imperfections in the analytical methods, and the uses to which these analyses can be applied will be very greatly restricted. Thus to give a concrete example: from gliadin, which constitutes a large part of the protein of wheat, upwards of thirty-five per cent. of glutaminic acid can easily be isolated, whereas from milk casein, under similar conditions, only about eleven per cent. can be obtained. Since about one-half of the products of casein are as yet unknown it is quite possible that among these is a quantity of glutaminic acid that, for some undiscovered reason, is held in solution, and this may be quite sufficient to make up for the apparently great difference between gliadin and casein.

We have now come to the point where the chemical individuality of our protein preparations is a matter of much importance for future studies, both chemical and physiological, and it will be well to review briefly the data which can help us to form some conclusions concerning this question. As this is the logical starting point for a discussion of the chemistry of the proteins I will take it up first.

A large number of protein substances are now on record to which special designations have been given, but about many of these we know at present comparatively little. To a few of them much attention has been directed, but unfortunately many of those who have worked with them have had little experience with such substances and their efforts have led to so much confusion that it is almost impossible to form any estimate of the value of the recorded data.

As the animal organism consists for the most part of protein, and as each individual protein occurs associated with many others, it has been especially difficult to isolate products of definite properties from such tissues. The animal proteins are the ones with which the majority of those interested in protein chemistry are familiar, and it is not surprising that the definite character of our so-called individual proteins is regarded with much more than suspicion. Very little really serious work has been done with any protein of animal origin except ovalbumin. This is the only one which has been subjected to careful fractional crystallization, whereby the constant chemical and physical properties of successive fractions have been established. In regard to crystallized serum albumin less is known than of ovalbumin.

In the case of the hæmoglobins the matter stands even worse,

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[3] Abderhalden and Samuely: *Z. physiol. Chem.*, **46**, 196 (1905).

for no extensive study of the products of fractional crystallization has yet been made, and some of the recorded data as to ultimate composition are manifestly wrong in consequence of analytical blunders. These, however, are still quoted as evidence of the uncertain composition of this substance, and it seems to be generally believed that it is impossible to make two preparations of these beautifully crystallizing substances which are alike.

The seeds of many plants afford the best material from which to obtain preparations of definite character, for in these we find a relatively large proportion of reserve protein, which is in a sense the excretory product of the protoplasm of the cells of the ripening seed. This reserve protein is far more stable than that from animal tissues, and usually can be subjected to extensive fractional crystallization, or precipitation, without showing any detectable change in properties. As such protein has the characteristic structure shown by the animal proteins it is the best material now at our disposal for a study of the chemical and physical characteristics of proteins in general, and apparently furnishes the best preparations for experimental studies of nutritional and other physiological problems. The knowledge gained by such study will to a large extent be applicable to proteins of animal origin.

In regard to the chemical individuality of any of the proteins nothing definite can be said, but there are good reasons for believing that many of those from seeds consist of but a single substance, as the methods which have readily shown the presence of two or more proteins, in preparation from some seeds, have not given the slightest evidence of an admixture in those from others.

The crystalline globulin edestin, which is obtained from hempseed, has been the subject of a most extensive fractionation under a great variety of conditions, and has yielded fractions which have not shown any differences which exceeded the limits of error of observation in ultimate composition, in the partition of nitrogen, or in specific rotation.[3] These facts are important, for edestin yields on hydrolysis just as complex a mixture of amino-acids as do any of the proteins yet analyzed, and hence affords no basis for the belief that the individual proteins, as we now know them, are mixtures of relatively simple polypeptides, each containing but a few of the amino-acids. It is impossible after my experience to believe, as Fischer suggests, that many of the seed proteins are mixtures of several substances of simpler constitution. If this view were correct, it would seem improbable that a substance which crystallizes readily in definite form would resist all possible efforts to break up the mixture to at least some extent. This

[3] Unpublished results obtained by the author.

question deserves still more critical study, and such work is now in progress in my laboratory.

I have gone into this question of the possibility of obtaining preparations of probable chemical individuality, because there is a widespread belief, largely founded on the indefinite character of the preparations of animal origin, that it is impossible to make protein preparations which are worthy of the consideration of the chemist.

To secure a few well characterized proteins is important to the future progress of protein chemistry, for our next task is to subject some of the best defined of these to exhaustive investigation of all their properties. It seems to me that only in this way can we ultimately acquire definite information which can be applied to proteins in general and thus obtain a secure foundation for physiological experiments and conclusions. In the process of differentiating the proteins the efforts of the earlier investigators were directed toward discovering similarities between those of different origin, for it was assumed that there were in nature only a comparatively small number of forms. As the means for differentiation were developed it gradually became apparent that the number of individual proteins was very great. The recently discovered precipitin and anaphylaxis reactions made it probable that an almost infinite number of chemically distinct forms occur in different animal and vegetable tissues, but the evidence was not conclusive that these reactions were actually due to the proteins contained in the different fluids and extracts which had been used in obtaining these reactions until Wells reported his anaphylaxis experiments, made a short time ago with carefully recrystallized ovalbumin. Some experiments with plant proteins, just published by Wells and myself, fully confirm this conclusion, and indicate very strongly that the specificity of the anaphylaxis reaction is intimately connected with the structure of the protein.

One series of our experiments are of direct interest in this connection, as they indicate that this reaction can be used to determine the relation of one protein to another, when these are so nearly alike that differences between them cannot be recognized by a most careful comparison of their physical and chemical properties. Preparations of globulin from the seeds of hemp, flax, squash, and castor-oil plant are obtained which are so nearly alike in ultimate composition, crystalline form, solubility and physical properties that only the most minute examination has revealed any differences whatever between them. We found that while all these proteins showed a strong anaphylaxis reaction, only those from the flax-seed and castor-bean showed any tendency whatever to react with one another, and between these the reaction was of a doubtful character. On the other hand, gliadin from rye reacted strongly with gliadin from wheat, a result in

accord with the fact that by chemical or physical means no differences have been detected which were sufficient to indicate that *these gliadins were different substances.* Likewise legumin from the pea reacted with the apparently identical legumin from the vetch. No reactions were obtained between proteins of distinctly different structure nor between those from seeds botanically unrelated.

From these facts it is evident that structural differences exist *between very similar proteins of different origin* and it is interesting to note that chemically identical proteins apparently do not occur in animals or plants of different species, unless these are biologically very closely related. In this respect the proteins are in marked contrast to the other constituents of plants and animals, for not only do identically the same sugars and fats occur in many species of plants and animals, but many of these are common to both forms of life. It thus appears that the chemical constitution of the proteins is closely connected with the biological relations of the forms of life which produce them, and that the morphological differences between species find their counterpart in the protein constituents of their tissues. A similar differentiation has recently been made by Reichert and Brown[4] on the basis of the crystalline form of the hæmoglobins, since the measured angles of the crystals show close generic relations.

We have thus far merely considered the fact that differences exist between the proteins, but for the present problems of physiology the extent of these differences is of much more importance, for it is only within the last ten years that we have come to realize that the differences in the structure of many of the proteins, especially some of those extensively used for food, are so great as to require a complete change in our views of digestion and assimilation.

The first observation of an important qualitative difference was made long ago on gelatin, which by its failure to give more than feeble Millon's reaction, was known to contain no tyrosine. This protein was, however, not regarded as a typical one, but was assigned to the group of albuminoids containing those protein-like substances which compose the greater part of various specialized tissues having little, if any, physiological activity. Since none of these substances were regarded as capable of supplying protein to the tissues when taken as food, no special importance was attached to the fact that gelatin was deficient in one of the common constituents of food proteins, although it was known that it was capable of replacing a part of the protein in a maintenance diet.

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[4] Reichert and Brown: Carnegie Inst. Wash. Pub. No. 116 (1909).

Attention was first directed in 1900 to the chemical constitution of food proteins, in their relation to nutrition, by Kossel and Kutscher,[5] who found that the alcohol-soluble proteins, which form a large part of the protein of wheat and maize flour, contained no lysine. These had long been used with success in feeding both men and animals, and the question of their nutritive relations was at once raised. I also found that zein, the alcohol-soluble protein of maize, which Kossel had found to yield no lysine, fails to give the Hopkins-Cole reaction, and therefore contains no tryptophane.[6]

In respect to quantitative differences between food proteins a series of determinations of the partition of nitrogen, made by Harris and myself[7] in 1903, showed that such wide differences in their structure existed that if these had equal values in nutrition a very considerable change in constitution must be effected in the process of assimilation which would involve much more elaborate synthesis than, at that time, was supposed to take place in the animal organism. A striking discovery, made in my laboratory, which showed to what extent quantitative differences might occur in proteins of recognized food value, was that gliadin from wheat flour yielded over 35 per cent. of glutaminic acid.[8] This observation was shortly followed by analyses of the products of hydrolysis of a large number of proteins from many sources, which have given us a general picture of the main peculiarities of most of those which are commonly present in our foods. In these analyses important differences in the proportion of each of the amino-acids have been revealed, especially among the reserve proteins of seeds. Thus through the gradually developed recognition of the fact that our food proteins differ widely in their constitution, entirely new aspects of the problems of digestion and assimilation have been raised, which are still the subject of investigation and controversy.

The physiologist may well ask, are these differences between the various food proteins as great as they appear to be? This question is justified, for, as I have already said, in these analyses hardly more than one-half of the total protein has been recovered in the form of definite products. Although there is no doubt that, in many respects, very considerable structural differences actually exist between many of the proteins commonly used for food, the degree of the accuracy of our present analyses should be considered in detail, so that the actual quantitative value of the determination of each of the amino-acids can be definitely ascertained.

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[5] Kossel and Kutscher: *Z. physiol. Chem.*, **31**, 165 (1900).
[6] Osborne and Harris: *J. Am. Chem. Soc.*, **25**, 853 (1903).
[7] Osborne and Harris: *J. Am. Chem. Soc.*, **25**, 323 (1903).
[8] Osborne and Harris: *Am. J. Physiol.*, **13**, 35 (1905).

As a critical study of these methods has been in progress in my laboratory for some time, it may be a matter of interest to you to know some of the results already obtained. Not only our own work, but that of other laboratories, has shown that the amount of ammonia yielded by hydrolysis is uniform for each protein, and can be determined with accuracy. The proportion of the protein nitrogen obtained as ammonia has thus been found to be four times greater in some proteins than in others. The amount of arginine, histidine, and lysine can be estimated by Kossel's method with a relatively high degree of accuracy and can be controlled by determinations of the quantity of nitrogen precipitated by phosphotungstic acid under definite conditions. The results of the direct estimations of the basic amino-acids have been found to be very nearly equal to the amount of these substances actually present, and to be strictly comparable with one another. The only uncertainty attaching to carefully made determinations is caused by incomplete hydrolysis of the protein; this can be controlled by estimating the proportion of nitrogen precipitable by phosphotungstic acid, after hydrolyzing with hydrochloric acid for different periods of time.

From the results that we have obtained from a number of food proteins it has been found that the proportion of arginine or histidine is about ten times as great in some as in others. The proportion of lysine varied from none to 6.43 per cent. of these proteins while the lysine, obtained from the crude muscle substance of chicken and halibut, reached nearly 7.5 per cent. of the dry material, indicating that the pure proteins of these tissues yield an even greater quantity.[9]

Tyrosine, which has always been isolated by direct crystallization, can probably be estimated with a reasonable approximation to accuracy, although, according to my experience, it can never be so completely separated from the mixture of the amino-acids as Abderhalden assumes, who has stated that it is possible to thus separate it completely and regards its determination as one of the most accurate of those employed in analyzing the products of protein hydrolysis. If only pure tyrosine is weighed it seems possible to determine its proportion with a close approximation to the truth, but it is not always possible to determine the purity of the products weighed by some of those who have published such estimations. The amount of tyrosine obtained from food proteins falls between 2 and 4.5 per cent., although as much as 10 per cent. has been obtained from some of the albuminoids.

It has been commonly assumed that glutaminic acid in the form of its hydrochloride can be almost completely separated from

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[9] Cf. Osborne, Leavenworth and Brautlecht: *Am. J. Physiol.*, **23**, 180 (1908).

the mixture of decomposition products by the method of Hlasiwetz and Habermann. Abderhalden has used this determination in order to show the relations of various proteins to one another, and has stated that the results are more nearly quantitative than those obtained for any of the other mono-amino-acids, with the exception of tyrosine. Confidence in the accuracy of these determinations has been largely founded on the close agreement between different determinations. Thus several investigators independently obtained from 10.5 to 11 per cent. of glutaminic acid from casein, and a like agreement was also obtained with several other proteins. In making these determinations the question whether the protein was completely hydrolyzed or not received little attention, for it was formerly assumed when the products of hydrolysis ceased to give the biuret reaction that the union between the amino-acids had been completely broken down.

Some time ago I found that a considerable quantity of an insoluble product was formed by hydrolyzing gliadin for several hours with twenty-five per cent. sulphuric acid, and that this, on subsequently boiling with strong hydrochloric acid, yielded relatively large quantities of glutaminic acid and cystine. The most direct evidence of the existence within the protein of a highly resistant union between two amino-acids was exhibited by the di-peptide of proline and phenylalanine which was obtained by Clapp and myself[10] from gliadin which had been boiled witb 25 per cent. sulphuric acid for many honrs. This di-peptide was completely hydrolyzed only by heating in a closed tube to a relatively high temperature for some time with strong hydrochloric acid. We thus have every reason to expect combinations of amino-acids which will require very energetic treatment with acids before they can be completely decomposed. These observations have led me to determine the output of amino-acids after prolonged boiling with strong hydrochloric acid, and as a result I have obtained from several proteins much more glutaminic acid than had formerly been isolated from them. Thus after doubling the time of hydrolysis of casein I have recently found, in five closely agreeing estimations, 15.5 per cent. glutaminic acid, or 50 per cent. more than was previously isolated. Zein, gliadin, and edestin have also yielded distinctly larger quantities than after the shorter hydrolytic treatment to which they had been previously subjected.

Before the results, thus far reported, in respect not only to glutaminic acid, but also to all of the other amino-acids obtained by Fischer's ester method can be accepted as final, they must be confirmed by new determinations made after boiling the proteins with strong acids until the hydrolysis is complete.

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[10] Osborne and Clapp: *Am. J. Physiol.*, 18, 123 (1907).

Heretofore we have had no means whereby we could satisfy ourselves that the union between all of the amino-acids had been broken apart and the acids set free. Sörensen's method of determining this by adding methylene to the amino-nitrogen, and estimating the proportion of free carboxyl groups by titration, does not yield satisfactory results in practice, as the endpoint of the titration is too uncertain. The method recently proposed by Van Slyke[11] for determining the proportion of free amino groups yields good results, and by its use the progress of the hydrolysis should be easily and accurately followed.

Although the yield of amino-acids can be increased by making the hydrolysis complete, the errors incident to the processes employed in isolating them involve losses which contribute largely to the deficit shown by the total of the products obtained in definite form. As no data were on record from which these losses could be even roughly estimated Jones and I[12] made a mixture of amino-acids in the proportion in which they had been obtained from zein, and analyzed it according to Fischer's ester method. We recovered only a little more than 80 per cent. of the leucine, about 70 per cent. of the proline and phenylalanine, and 40-50 per cent. of the alanine, valine, and aspartic acid, and none of the serine. In making this test analysis, ill-defined products similar to those observed in the course of an ordinary protein analysis were formed, showing that decomposition of the esters took place during the distillation.

By correcting our analysis of zein for corresponding losses 92.7 per cent. was accounted for as consisting of those amino-acids which are now recognized as protein decomposition products. Hence nearly all of the deficit shown by the analysis of zein may fairly be attributed to analytical errors, for the presence of 0.6 per cent. of sulphur shows that a part of the substance, still unaccounted for, belongs to some sulphur-containing complex, and also a part unquestionably to serine which, we are convinced, must have been present in much larger amount than that isolated. We cannot apply corresponding corrections to the analyses of other proteins until these have been subjected to further careful study, for differences in the constitution of the mixture of amino-acids may lead to losses quite different in extent. From the experience gained in this case, however, the way appears open for further investigations which should give us a more definite conception than we now have of the constitution of some of the more important food proteins.

Proteins which, unlike zein, give a strong Molisch reaction and contain carbohydrates, deserve especial consideration, for in the

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[11] Van Slyke: *Ber.*, **43**, 3170 (1910).
[12] Osobrne and Jones: *Am. J. Physiol.*, **26**, 30 (1910).

analysis of these the carbohydrate complex may have a pronounced influence on the results. It is generally assumed that carbohydrate complexes form an integral constituent of the molecules of many of the proteins. An amino-carbohydrate has been obtained from ovalbumin, ovomucoid and some of the mucins, but attempts to isolate any such substances from many other proteins have failed. The fact that most protein preparations give the Molisch reaction has led to the assumption that these contain some carbohydrate, but my experience has led me to believe that in most cases this reaction is caused by impurities in the preparation and not by a constituent of the protein molecule. This is certainly true for many of the plant proteins, from some of which every trace of carbohydrate can be easily removed, while from others this can be done only with difficulty.

Of the proteins which contain phosphorus we have two types—the nucleoproteins and the phosphoproteins.

Little need be said concerning the constitution of the nucleoproteins, other than that these are natural or artificial combinations of simple proteins with nucleic acid. The constitution of the nucleic acids has been revealed largely by the brilliant work of Levene and Jacobs,[13] but as these form no part of the protein molecule a discussion of their decomposition products lies outside the scope of this lecture.

The phosphoproteins, which like milk casein or ovovitellin, contain phosphorus, but not nucleic acid, present a wholly different problem, for in these the phosphorus appears to bear some relation to the protein molecule. No non-protein, phosphorus-containing group has yet been obtained from these proteins, and it cannot be assumed that these are combinations of phospborus-free protein with such a complex, although the fact that the total quantity of decomposition products accounted for in analyzing both casein and ovovitellin is small indicates that this may be the case.

This brief review will have little interest for you unless in connection with it I consider some of the problems which have been presented to the physiologist by the recent investigations in the field of protein chemistry.

The most important of these problems have been raised by the discovery that many of the proteins which are extensively used for food differ much in constitution, not only from the tissue proteins of the animal, but also from each other. In consequence of this the older views of protein assimilation have been abandoned, and a multitude of new questions now demand an answer. Since we can no longer assume that the food protein is but slightly changed in the process of digestion before conversion into the

[13] Levene and Jacobs: *Ber.* **43**, 1 (1910).

animal tissues, we must consider in how far it is decomposed by the digestive enzymes and to what extent a re-synthesis is effected in the process of assimilation.

A number of distinct and independent problems are thus raised, each of which must be settled before these questions can be answered.

First: To what extent is the protein decomposed by the normal process of digestion?

Second: To what extent does the animal synthesize the products of protein hydrolysis?

Third: What is the minimal protein requirement of the animal? In other words, how much of the food protein actually replaces protein waste in the tissues, and how much is burned, without ever being converted into tissue substance?

Fourth: To what extent do intestinal bacteria take part in these processes?

All these questions have been the subject of investigation and discussion, but a conclusive answer has not yet been obtained to any of them.

It has long been known that some of the ultimate products of protein hydrolysis occur in the intestine, although the importance of the earlier observations has only recently been recognized. Thus Koellicker and Müller,[14] in 1856, found leucine and tyrosine there, and later Kühne[15] confirmed their observation, but considered these to be by-products of the action of trypsin. As you all know, Kühne assumed that under the action of trypsin the proteins can be decomposed into nearly equal parts, which he called respectively hemi- and anti-peptone, and by the continued action of trypsin the former is completely converted into amino-acids, but the latter is resistant to any further action of this enzyme. He, however, did not believe that in the normal digestion the decomposition of the hemipeptone was carried to the amino-acid stage.

In 1901 Kutscher and Seemann[16] found that protein was normally converted into amino-acids in the intestine and supposed that these served as the material from which the new body protein was constructed. At the same time Cohnheim[17] showed that the intestine contained the enzyme, erepsin, which, although without action on native proteins, converts the proteoses and peptones formed by pepsin and trypsin completely into simpler products, among which amino-acids are abundant. Thus almost at the very

[14] Koellicker and Müller: *Verhandl. physik.-med. Ges. in Würzburg*, **6**, 507 (1856).

[15] Kühne: *Arch. path. Anat. (Virchow's)*, **39**, 155 (1867).

[16] Kutscher and Seemann: *Zentr. Physiol.*, **15**, 275 (1901).

[17] Cohnheim: *Z. physiol. Chem.*, **33**, 451 (1901).

time when chemical investigations made it necessary to assume that the food protein is decomposed into amino-acids and new protein reconstructed from these products of hydrolysis, physiological investigations showed that the animal organism was equipped with enzymes able to accomplish this result.

However, it still remains undecided whether decomposition of the food protein, under normal conditions, is actually carried to a complete conversion into amino-acids, for Fischer and Abderhalden[18] consider this to be highly improbable, and suggest that it is possible that, after a certain proportion of amino-acids are split off, a nucleus may remain to serve as a basis for the construction of new protein.

The question of in how far the animal is able to synthesize protein from the products of protein hydrolysis has been put to a direct test. Loewi,[19] Lesser,[20] Abderhalden and Rona,[21] Henderson and Dean[22] and others have found that not only nitrogen equilibrium but even a distinct nitrogen retention could be obtained by feeding animals with the products of tryptic digestion, but not with the products of acid hydrolysis.

It has been thought that the products of tryptic digestion serve to maintain the animal better than do those of acid hydrolysis because they contain undecomposed polypeptide complexes which may serve as a nucleus to which amino-acids of the proper kind and in the right proportion are added. It has also been supposed that the products of acid hydrolysis fail to maintain the animal because of the destruction of some one, or more, essential constituent of the protein through secondary decomposition caused by the acid, for it is known that such occur, notably in the case of cystine and tryptophane.

The question of the dependence of protein synthesis on the structure of the food protein has been investigated by Abderbalden and Samuely,[23] who sought to detect a change in the glutaminic acid content of the serum albumin of a horse after feeding large quantities of wheat gliadin, from which several times as much glutaminic acid can be obtained as from serum albumin. As no change in the composition of the blood albumin could be discovered they concluded that the composition of the food protein had no influence on the composition of the blood proteins.

The same question was also experimentally tested by Michaud,[24]

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[18] Fischer and Abderhalden: *Z. physiol. Chem.*, **39**, 83 (1903).
[19] Loewi: *Zentr. Physiol.*, 590 (1902); *Z. Biol.* **46**, N.F. **28**, 113 (1904); *Arch. exp. Path. Pharmakol.* **48**, 303 (1902).
[20] Lesser: *Z. Biol.* **45**, N.F. **27**, 497 (1904).
[21] Abderhalden and Rona: *Z. physiol. Chem.*, **52**, 507 (1907).
[22] Henderson and Dean: *Am. J. Physiol.*, **9**, 386 (1903).
[23] Abderhalden and Samuely: *Z. physiol. Chem.*, **46**, 193 (1905).
[24] Michaud: *Z. physiol. Chem.*, **59**, 404 (1909).

who founded his experiments on the assumption that the animal requires for the construction of its body proteins a definite proportion of each of the amino-acids which enter into their constitution. He therefore thought that an animal could be maintained in nitrogen equilibrium by a smaller amount of protein consisting of a mixture of the tissues of an animal of the same species than of protein of distinctly different constitution. He accordingly fed dogs on a mixture of minced dog tissue, and compared the nitrogen balances with those obtained with food mixtures which contained the same quantity of nitrogen in the form of gliadin, edestin, nutrose, casein, dog serum proteins or horse flesh. The results which he obtained were very striking. The minced dog tissues were far more effective in preventing loss of nitrogen than either gliadin or edestin, and distinctly more effective than casein. The differences obtained with dog serum proteins, or with horse flesh, were too slight to lead to any definite conclusions.

The question of protein synthesis by the animal has also been studied by aid of the so-called "incomplete proteins." The numerous older experiments with gelatin, which lacks tyrosine, have led to the belief that this alone cannot support life, but that when added to a food containing other proteins it is capable of replacing a considerable part of the protein required to maintain nitrogen equilibrium.

Wilcock and Hopkins[25] found that zein, which lacks glycocoll, lysine, and tyrosine, failed to keep mice alive for more than a few days, but that if tryptophane was added they lived somewhat longer.

Henriques[26] fed rats with zein and also with gliadin, which lacks glycocoll and lysine, and found that he could not secure nitrogen equilibrium with zein but could do so with gliadin if fed in sufficiently large quantities. He concluded that probably the absence of tryptophane rendered zein incapable of supporting an animal, but the absence of lysine from gliadin was not of essential importance.

Definite data concerning the minimal protein requirement of the animal are lacking. In complete starvation a considerable quantity of nitrogen is eliminated which is much reduced if the energy requirements of the animal are satisfied by feeding sufficient carbohydrate. Michaud's experiments have shown that this quantity can be still further reduced by interposing a period of feeding with a minimal quantity of protein and then again feeding with nitrogen-free food, but his experiments left him in doubt as to whether or not the output of nitrogen thus found corre-

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[25] Wilcock and Hopkins: *J. Physiol.*, **35**, 88 (1906).
[26] Henriques: *Z. physiol. Chem.*, **60**, 105 (1909).

sponded to the destruction of tissue actually necessary to maintain the physiological functions of the body. This is of importance in connection with the question of the synthesis of body protein from food protein, for we must know how much of the latter is required for this purpose if we are to interpret the results obtained in feeding animals with proteins of different constitution. From Michaud's results it is evident that only a small part of the food protein commonly consumed is necessary to supply the tissue waste incident to the performance of the purely physiological processes required to support life, and that consequently, under normal conditions, a synthesis of new protein probably occurs to only a small extent.

The part which intestinal bacteria may play in the synthesis of body protein from food protein deserves much more attention than it has received. It is well known that bacteria are present in large numbers in the intestine, for from 30 to 40 per cent. of the fæces may consist of the bodies of these organisms.

Before we can accept as conclusive any of the evidence that has been offered that the animal actually synthesizes tissue proteins from the constituents of its food, we must carefully consider the data just set forth, not only in connection with each other, but also in connection with some other facts which have been recently discovered.

From Michaud's experiments it is evident that only a small part of the food protein normally consumed is used for the construction of tissue protein, and that consequently when the animal receives an abundant supply of food a deficiency in one or more of the essential constituents of the protein may not become apparent for a long time. Furthermore, such a deficiency may be supplied by the animal's own tissues, for we know that the muscles form a reserve supply which furnishes the necessary protein required during long-continued starvation and also serves for the construction of new tissues, under normal conditions, as shown by the development of the reproductive organs of the salmon.

It is, consequently, probable if the synthesis of the animal proteins is affected by a recombination of amino-acids that the deficiency of any one of these in the food protein will become apparent only when the experiments are carried on for much longer periods than has thus far been done in testing the proteins in respect to their relations to protein synthesis in the animal body.

All the experiments in this direction which have been made with the incomplete proteins are wholly inconclusive because similar experiments made with complete proteins have likewise failed, with the exception of one by Röhmann, in which he used a mixture of several proteins.

The fact that a nitrogen balance is not obtained in such experi-

ments is no evidence that the fault lies in the constitution of the protein, as I shall soon show. Also a retention of nitrogen obtained for a time with a protein or its decomposition products is not evidence that these have been utilized in the construction of new tissue.

That the products of tryptic digestion maintain the animal for a short time while the products of acid hydrolysis fail to do so is not evidence that some essential amino-acid has been destroyed by boiling the protein with strong acid, for the failure of the latter may as well be due to the presence of some more or less toxic secondary decomposition product, as is indicated by the digestive disturbances noted by all those who have fed such substances.

Michaud's discovery that proteins which in constitution closely resemble the body proteins, prevent loss of nitrogen from the body better than do proteins which differ widely in their constitution from the body proteins, is the best evidence that we have that amino-acids from the food protein are actually used for the construction of the tissue proteins. This, however, is not wholly convincing, for Michaud's experiments are, in fact, a comparison of the nutritive effect of animal tissue substance with the nutritive effect of a mixture of isolated protein and other substances. It is also to be noted that he makes no mention of the addition of inorganic constituents to these mixtures. It is not surprising, therefore, that he should have obtained the best results with the tissue feeding, for the comparative failure of the isolated proteins may have been due to other causes than differences in their constitution.

In none of the experiments thus far discussed has consideration been given to the possible influence that bacteria may play in the transformations that are required to convert a protein of wholly different constitution from the tissue proteins into the substances which compose the body of the animal. The capacity of these organisms to effect profound chemical changes is quite sufficient to transform a considerable part of the amino-acids which result from digestion of the food protein into forms of totally different constitution. By this means an excess or deficiency of one or another amino-acid may be compensated and the animal supplied with an entirely different combination of amino-acids from that originally fed to it. To what extent such changes occur in the intestine, or to what degree the substance of the bacteria is digested and assimilated, we do not know. The fact that animals in cages on restricted diets are prone to eat their own fæces indicates that they thereby secure some element of food which they crave, and is suggestive that the bacteria may have more influence in feeding experiments than has heretofore been supposed.

After all that has been said and written concerning the synthesis of the body protein by recombination of the amino-acids from the

food proteins, it must not be forgotten that in the process of digestion the amino-acids themselves may be deaminized and converted into wholly different substances, and that from these new products the amino-acids required by the animal may be later reconstructed.

Many facts have indicated that this may happen, but the most important indication has very recently been given by Embden and Schmitz, who have found by perfusing the excised liver with blood to which pyroracemic acid or lactic acid had been added that alanine is formed. They also obtained tyrosine and phenylalanine after adding oxyphenylpyroracemic acid or phenylpyroracemic acid respectively.

In reviewing the literature of feeding experiments made with a view to determine the possible synthesis of protein by the animal, it is evident that these have been much too brief and have been made without sufficient consideration of many important factors. In most of these the ages of the animals have not been given, in others the isolated proteins have been commercial products of doubtful purity or have been prepared in the laboratory by hasty methods which do not yield products of definite character; no sufficient consideration has been given to the requirements of the animal for inorganic constituents, and none whatever, so far as I can find, to changes caused by intestinal bacteria in the constitution of the nitrogenous elements of the food. Each of these factors may have an important influence and must be the subject of special investigation before final conclusions can be reached. Such investigations must be made along many lines before a foundation can be secured from which conclusions of value can be drawn. These problems are among the most complex that have been presented to the physiologist, and it needs but a little reflection to show that a solution can be reached only by long-continued and patient work.

A beginning in this direction was made about a year and a half ago by Mendel and myself with the hope that in time we may secure some data which may ultimately be of help in solving some of these important questions of nutrition. Our experiments, which have thus far been conducted with rats, have already yielded some interesting results.[27]

From a large number of experiments with many different proteins, singly and in combination, we have learned that the cause of failure in most of the previous experiments is due to an unsuitable choice of the inorganic constituents of the food. By using an inorganic salt mixture similar to that used by Röhmann, in the only approximately successful artificial feeding experiments heretofore reported, we have succeeded in keeping rats, not only in

[27] Carnegie Inst. Wash. Pub. No. 156 and No. 156, Part II.

positive nitrogen balance, but in full weight and perfect health over long periods of time. Thus in our most successful experiment we have kept a rat for ten months; for the first two months on a mixture containing milk casein and wheat glutenin, and for the succeeding eight months on one containing wheat glutenin as its only protein. Many other rats have been kept in fine nutritive condition for long periods with casein or mixtures of casein with other proteins. When the conditions for such experiments are well established we expect to extend them to the many forms of food proteins with the hope of learning something more definite than is now known of the effect of differences in the constitution of the food protein on nutrition.

One of the most interesting results of our experiments has been the discovery of the fact that while a mature rat can be maintained on a food containing the isolated proteins, a young rat, on the same food, fails to make more than the slightest growth. Three young rats which weighed from 60 to 70 grams each have been fed for more than three months with the same glutenin food, which fully satisfied all of the requirements of the mature rat just mentioned. All of these have remained nearly stationary in weight, although during the entire period the food intake has been fully equal to that of other rats of similar weight which were in full normal growth. Many experiments with other proteins, including milk casein, have given a similar result, and we have also found that such stunted animals when transferred to a normal mixed diet, or to one containing milk powder, at once grew normally. Future investigations must show whether or not this means that a mature animal actually constructs little if any new tissue protein from its food protein, and that a growing animal, which must do so, is unable to utilize proteins of widely different constitution from its tissue proteins for this purpose. The possibility that this may be so is suggested by the interesting experiments by Aron,[28] who finds that dogs which are kept on such a restricted quantity of mixed food that they do not increase in weight during long periods grow in size at the expense of their muscular tissues, so that their skeletons are equal in weight to those of normally nourished dogs which have doubled their weight during the same time. Although we have not yet measured the different parts of our stunted rats it is evident from their appearance that their skeletons have not developed to any marked extent. They look exactly as if tissue growth had entirely ceased from the beginning of feeding with the single protein, and, if this is so, it is possible that they cannot make new tissue from the pure protein of their food. The slight growth made by some animals when thus fed can easily be attributed to the activity of intestinal

[28] Aron: *Biochem. Z.*, **30**, 207 (1910).

bacteria which convert a small part of the food protein into other forms from which new tissues could be constructed. This possible participation of bacteria immensely complicates the conduct of such feeding experiments, and renders the interpretation of the results difficult, for even if the fæces are in some way collected so that the animal cannot eat them we have no assurance that dead bacteria may not be digested within the intestine and thereby supply the animal with substances which have been carefully excluded from the food.

WHAT AND HOW MUCH SHOULD WE EAT?[1]

I

Under normal conditions of supply and normal conditions of health, little attention is given by the great mass of mankind to the question what or how much should be eaten. They simply eat what they want and as much as they want, and then stop and go about other business. They know nothing of the dietary elements which the nutrition expert tells them are so essential for their well-being, and even for their very existence.

How can they long survive in such ignorance? Why does the community allow them to endanger, not only their own lives, but those of posterity? The only possible answer is that they are endowed with instincts which guide them so well, that under normal conditions of life they escape the many dangers that until recently they were unconscious of.

In view of the successful part played by instinct in dealing with the problems of nutrition,—which modern science is beginning to show are among the most complex that the human mind has ever yet undertaken to investigate,—perhaps it might be well to pay a little more respect to instinct than has lately been the fashion, and at the same time see if by observation some useful hint may be obtained which will help in interpreting the results of investigations in the laboratory.

Even the pig knows how to protect himself against dangers arising from indiscretions in eating, not only as to quantity, but as to the proportion of the various food-constituents. This is shown by Evvard's experiments. He allowed pigs to feed themselves *ad libitum* with corn, meat-meal, oil-meal, salts, and the like, from separate hoppers. During early growth, when new tissues were being made rapidly, these pigs ate much larger proportions of protein than when growth became slower. Later, when smaller amounts of corn were eaten, the protein deficiency

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[1] Reprinted from *The Atlantic Monthly* for September, 1918, by permission of the editor.

thus caused was met by an increase in the amount of meat-meal eaten. Under these conditions of free-choice feeding the pigs grew faster than any previously recorded which had been fed on mixtures made for them by the combined talent of agricultural experts, trained both in the science of nutrition and in the practice of the art of feeding.

Similar experiments made in my laboratory with albino rats gave much the same results. These animals were given their choice between two food-mixtures, one adequate for growth, the other inadequate, owing to the deficiency, or absence, of some one factor essential for growth. Although these foods were alike in physical properties, and so nearly alike in their constituents that it was difficult to believe that the rats could distinguish between them by any of their senses, nevertheless, all but one of the several rats so chose their food as to make practically normal growth. How they did this is one of the wonders of nature.

Considered solely from the standpoint of a supply of energy,—that is, of fuel for the maintenance of the body as a running machine,—the food-problem has long been the subject of very carefully and accurately controlled experiments. These have shown that, for the expenditure of a given amount of energy in the performance of physical work, a corresponding amount of potential energy in the form of food is required. In other words, the law of conservation of energy applies to the animal machine as strictly as it does to the machine in the factory.

The practical conclusion to be drawn from this is that the animal body must be supplied with enough energy, not only to keep it running, but to perform the work done by it. Recently we had an illustration of what happens to the machinery of our industries when the supply of energy in the form of coal runs short; and we may soon have an illustration of what will happen to the labor employed in these industries if the supply of energy in the form of food suffers similarly.

Let us first consider the question how much energy is really needed; or, to put it the other way, how little food can we get along on and still do the work necessary for the successful conduct of the war? As already stated, the relation of food eaten to the energy expended has been very carefully established by exact experiments which, under the conditions studied, are beyond criticism. How can these studies be applied to the needs of daily life? It is obviously impossible to determine the energy expended by a blacksmith working on a battleship, or an engineer running a locomotive, or a horse ploughing a field. None of these can be put to work in a calorimeter and the heat value of their work measured, nor can any imitation of such working conditions be reproduced whereby even an approximate estimate might be made. Nevertheless, authorities on nutrition furnish us with

tables showing how much energy must be supplied in the form of food for those who are engaged in a very wide variety of occupations, and these tables are largely used in determining suitable rations under different conditions.

It may fairly be asked, if it is impossible to measure the energy expended, how have such tables been made? They have been made by carefully studying the amount of food actually eaten by large numbers of people engaged in all sorts of occupations, and determining the calorific value of these foods. The energy expended in the various occupations was not measured directly by scientific methods, but indirectly, on the assumption that it is the habit of people, as well as of animals, to eat according to their calorific requirements. If men and animals were not endowed with instincts that enable them to adjust their food intake to the energy expended in maintaining their bodies, as well as in doing their work, they would be constantly suffering from the ills of over-eating or of under-nutrition.

That nature provides protection against many misfortunes which may befall an individual in the course of life, has been pointed out most interestingly by Dr. Meltzer in a paper on "The Factors of Safety in Animal Structure and Animal Economy." From the numerous examples set forth by Meltzer it seems probable that the ills following over- or under-eating are, in some way, also provided against. It has long been recognized that underfeeding is temporarily guarded against by a conversion of sugar into a substance similar to starch,—glycogen,—and storage of this in the liver and muscles. The potential energy thus husbanded is readily drawn on or replenished according to the minor fluctuations in demands for more, or for less, energy, which may be made necessary by the daily variations in physical activity, or the daily changes in external temperature. Larger demands, extending over longer times, are met by the reserve of fat and muscle-tissue, which in every normally nourished individual is sufficient to supply enough energy for a not inconsiderable time.

Are these the only means of dealing with inequalities in energy output, or food-supply? It is conceivable that, in addition, the speed at which chemical changes go on within the body may vary, to adjust consumption to requirements. Allen and DuBois state that the profound effect of confinement and under-nourishment on heat-production has never received the attention it deserves. If reducing the body weight, by lowering the food-intake below the amount which instinct prompts, reduces the rate of metabolism,—that is the sum of the chemical changes which are taking place within the body,—we should expect the converse to be true, and to find that increasing the food-intake above the amount that can be met by storing glycogen and fat is further met by an increase in the rate of metabolism. If it should turn out that a change in

the rate of metabolism thus provides a hitherto unrecognized factor of safety, the whole question of over-eating will have to be considered from a new angle.

It has been generally held that over-eating, except within narrow bounds, is impossible, for the subject will either grow fat, which of course has its limits, or will feel badly and cease to eat in excess until a normal condition is reëstablished, or will dispose of the surplus food by exercise. According to this view, those who cannot live in comfort without a game of golf or some other agreeable form of activity are habitually over-eating, in so far as fuel needs are concerned. There are other factors, however, involved in the exercise problem, which we will consider later.

If surplus food above that needed for the daily tasks of life can be disposed of by an increased rate of metabolism, we ought to know more about it than we now do if we are to deal with the problem of the most efficient use of our food-supply. Can any important amount of food be wasted in this way? A certain rate of metabolism is required to support the body functions and temperature, and a corresponding quantity of food is necessary to continue that metabolism, if body tissues are to be maintained. If more than this amount of food is eaten, it is wasted, if it serves no other purpose than to produce useless heat which must be gotten rid of in some way.

In my own case it has seemed that an unaccustomed plethora of food has been followed by a continued sensation of heat, and efforts to dispose of this extra heat by reducing my clothing below that habitually worn. If subjective sensations of this kind are to be trusted, it would seem that under such conditions surplus heat is being eliminated by radiation in consequence of dilation of the capillary blood-vessels. This agency is provided to rid us of the excess of heat incident to physical work; and it would seem not improbable that it might be called on to dispose of surplus heat produced by increased metabolism caused by an excess of food.

The extra heat eliminated after eating protein, which Lusk properly regards as a result of stimulated metabolism, is an example of wasted energy of the same kind that may result from a plethora of other kinds of food. Another example is the increased rate of metabolism caused by caffein, which may explain the extensive use of coffee and tea. So long as carbohydrates or fats are assimilated only in amounts in excess of the maintenance and energy requirements which can be met by storage in the form of glycogen or fat, no evolution of heat can be expected; but when the amount is greater than can be thus cared for, the plethora must be burned, if bodily health is to be maintained.

To what extent a surplus of food can be disposed of by such an increase in the rate of metabolism, or whether such a stimulation

of the metabolism can be frequently endured without sensations of discomfort, are questions which have been so little studied that definite answers cannot be given to them. My own observations have led me to suspect that there may be a wider difference in the capacities of individuals thus to meet the dangers involved in occasional over-eating than has heretofore been supposed. Possibly those who are said to have "good digestions" are those whose metabolism is easily stimulated, so that they are able to oxidize promptly whatever surplus food they may happen to eat. If such should prove to be the case, the ills commonly attributed to indigestion may in many cases not be due to a failure to digest food, but may, on the contrary, be the result of assimilating food which has already been digested in greater quantity than the body-cells are capable of oxidizing promptly.

Waste of food, if in fact there is any, from this source is doubtless small, and quite likely is fully compensated for, because a large proportion of the "good feeders" are among the most efficient in every community. While many seem to think that high thinking and plain living are essential to good living, it does not by any means follow that a high plane of metabolism does not imply a high plane of both mental and bodily efficiency. Certainly, among cold-blooded animals the increased rate of metabolism which results from raising the temperature of their environment leads to marked evidences of increase in physical efficiency.

II

Leaving this question for future investigations to settle, let us consider whether we have at present any better means of determining how much food—how much energy—is needed under given conditions than our present one founded on observations of what people actually eat when guided solely by their instincts?

It is very generally assumed that those who are in a position to do so eat too much, probably because all of us are tempted to eat when confronted with an abundance of attractive food. Although many do yield to this temptation, few fail to eat less at subsequent meals, and soon reduce their consumption, even if enticing food is continually put before them. A millionaire could not possibly eat as much in a week as a coal-heaver, unless he engaged in exercise more severe than would be agreeable. How much more than is necessary can be eaten without discomfort? Does over-eating cause a waste of food sufficient to justify the efforts necessary to control it? Can a man over-eat habitually, without either growing very fat, or becoming a dyspeptic? Does not this evil usually cure itself? Here are questions which are difficult to answer positively. Plenty of people will answer them with assurance; but have they good reasons for their answers?

It is difficult to fatten animals beyond a certain limited degree, and even then it takes a long time. If too much tempting food is supplied, they "go off their feed." Even pigs, as has already been stated, can successfully feed themselves from hoppers with concentrated foods. They apparently do not eat too much. Occasionally cattle or horses which by chance get access to the feedbin will eat so much that they die; but such cases are probably nutritional accidents, where fermentations cause decomposition of the food before it can be digested. During parts of the year almost all animals in a state of nature have the opportunity to eat too much, but we have no reason to believe that they do so. In a long experience, gained by feeding many hundreds of albino rats whose food-intake was limited only by their instincts, I have never suspected that any one of them ate too much. Successful stockmen make their animals eat all they will, in order to obtain maximum production and profit.

Excess of food results in accumulations of fat, but these form comparatively slowly. Chickens or Strasburg geese are fattened more rapidly by force-feeding than in the natural way, because thus they can be made to consume more food than their instincts will permit. Pigs can easily be made very fat; but these animals have been bred for generations with the purpose of developing a breed having a capacity for accumulating fat beyond the normal. Taking the country over, fat men are not very numerous, and most fat women have spent years in becoming so. There is probably far less over-eating, as measured by accumulations of fat above the normal, than is popularly supposed; but that there is some is evidenced by the not inconsiderable number of fat people, especially women, seen in our large cities.

Since the records of what people on the average actually do eat when left entirely to their instincts have been demonstrated to be on the average very nearly what they should eat for the proper maintenance of their hodies, it appears that in general there is not much, if any, over-eating. Such as may occur can be controlled by the scales; for if one is not obviously fat or gaining weight, he is presumably not over-eating. There is evidently little food saving to be expected from efforts directed to suppressing over-eating.

If the food supply is to be conserved by reducing the amount of food below that now eaten under the direction of instinct, what will be the result? The first effect will obviously be a loss of weight and consequently a reduction in the amount of food needed to move the body, as in walking, getting out of bed, or rising from a chair—a very small fraction of the total needed for maintaining the bodily machine and performing the tasks of daily life. It will not reduce materially the amount of food needed to do the work of daily life; for, as Anderson and Lusk have recently

shown, the energy requirement for work done is exactly the same whether the animal is well fed or starved. All that is saved by reducing weight is merely the fuel needed to do the mechanical work involved in moving the smaller load imposed by body weight. Experiments to show the reduction of energy resulting from reduction in weight have been made chiefly on men or animals whose work consisted in lifting the body, as in walking, or hill-climbing. Under such conditions a diminution of energy expenditure is involved which is almost proportional to the reduction in body weight. Under the conditions of activity of the great mass of our population, no corresponding saving can be expected, for few are engaged in occupations where lifting the body comprises more than a very small part of the mechanical work which they do.

Loss of weight involves loss of the factor of safety which nature provides in the form of fat; for even those who are not commonly regarded as "fat" have a very considerable amount of fat in the various tissues of their bodies. It may also involve a loss of substance from the muscle-tissues, if the reduction in weight is carried far, or if the subject was at the outset supplied with fat below the normal. Just what effect it has on the easily mobilized supply of glycogen which is needed to maintain uniformity in daily metabolism, I do not know. It would seem as if this too might be reduced to a minimum inconsistent with efficiency. There is no doubt that a certain amount of reduction in weight can be endured by the vigorous for a considerable time, but not without serious loss in efficiency, if long continued. In every community there are many men below the normal weight, and these are always looked upon with suspicion by insurance companies and enlistment officers, even though no pathological cause can be found for their underweight.

Restriction of the food-intake means the loss of a factor of safety other than that furnished by body fat—one that is in the food itself. Food furnishes more than fuel for the body: it supplies, in addition, the materials needed to renew the wear and tear incident to life, and also those mysterious substances called vitamines, the absence of which in a food renders it incapable of supporting life. No one knows what vitamines really are, for as yet they have not been isolated. Their presence is revealed only by the effect they produce upon nutrition. They are not uniformly distributed in the various parts of the plants and animals we use as foods; and in rejecting a part of an animal, or by over-refinement in milling, we may throw away these indispensable substances. The germs of wheat, rice, and other seeds, the liver and kidney of animals,—all of which are composed of highly active cells,—and the cells of yeast, contain a far larger proportion of vitamines than do the endosperm or berry of wheat and rice, or the muscle-tissue of the animal. Addition of a very

small quantity of the germ of the wheat-kernel to a vitamine-free but otherwise adequate mixture of nutrients, renders it capable of sustaining life; whereas a very large addition of white flour scarcely suffices.

Whenever the food-intake is cut down, the supply of vitamines is reduced, with how serious an effect no one as yet knows. That the need for vitamines is quantitative has been demonstrated within the last few months. The weight and health of animals fed on a diet free from vitamines, but otherwise fully adequate, can be maintained so long as they are supplied each day with a small but definite amount of yeast or wheat-germ or some other substance rich in vitamines. If the daily dosage is gradually reduced, a point is reached at which body weight begins to fall and the health of the animal is impaired. Further reductions in the amount of vitamines are followed more rapidly by these evidences of malnutrition. Body weight and health can be restored at once by increasing the daily supply. While in general, for the animals of a given species, the necessary amount of vitamine-containing material is nearly the same, there are individuals who require a larger or a smaller quantity. Vitamines seem to act as if they were stimulants to the metabolism, and individuals seem sensitive to this stimulus in different degrees. Do not vitamines play a part worthy of consideration in connection with restricted food-supplies?

An apparent example of the mysterious way in which instinct guides human beings to secure a supply of vitamines is shown by those tribes of Eskimos who eat the contents of reindeer stomachs as a delicacy. Doubtless the lack of this necessary element in the Eskimo dietary, which is largely made up of meat and fat, is the reason why the vegetable tissues gathered in their roamings by reindeer, and collected in their stomachs in an easily obtainable form, are regarded by the Eskimos as tidbits.

It is not at all improbable that many delicate people of sedentary habits, who eat but little, suffer chiefly from a deficient supply of vitamines, enough of which in the diet appears to impart physical vigor. Here we may have a clue to the reason for the benefit which exercise seems to confer upon people who otherwise lead physically inactive lives. The more these exercise, the more they eat; hence, the more vitamines they get, the better they feel. Those who never take exercise, but are always well, are perhaps persons so constituted that they react readily to a relatively small proportion of these life-giving substances.

III

How much protein should be included in the daily diet, is a question which has been the subject of contention among physiologists and nutrition experts for a long time, and as yet no agree-

ment appears to be in sight. That those who can afford to buy the expensive foods which supply this element customarily eat more protein than they actually need to maintain their bodies in seemingly good condition, has been demonstrated by the well-known experiments of Chittenden, who showed that men can live for several months without apparent detriment on diets containing about one-half the amount of protein usually eaten. That similar low-protein diets can be used continuously, is shown by the fact that many eastern races habitually live on such.

The low-protein diets of the masses in Japan are unquestionably the result of necessity, for the more prosperous classes in that country provide themselves with foods very similar to those common in America. This change in habits is more likely to be the result of instinct than of a desire to imitate Europeans. It is a matter of common experience that dietary habits which satisfy the promptings of instinct are among the most difficult to change; whereas those which do not satisfy instinct are very easily changed. That more protein should instinctively be eaten than is absolutely necessary, is in accord with the plan of nature of averting danger by providing a factor of safety. Too little protein leads to inevitable disaster, too much (within reasonable limits) can be disposed of without apparent harm.

Physical well-being can be maintained within very wide limits of protein intake. Just where the minimum, and where the maximum lies, is not certain, but that these limits are avoided by normal persons is certain. I have known a number of individuals who lived with enthusiasm for quite a time on low-protein diets, and who thought that their health was thus improved. All but one of these are now eating the normal amount.

There is no denying the fact that mankind in general instinctively eats more protein than the physiologist tells us is needed for actual maintenance. Why should this be so? One reason has been discovered since the experiments were made on which this dictum was founded, and this is, that all proteins do not have the same nutritive value. A quantity which fully suffices for all the bodily needs when one kind of protein is eaten, may be insufficient if another is eaten in its stead. To guard against this danger, we all instinctively eat a variety of foods, hence a variety of proteins; and it is curious how the selection thus made agrees with what our new knowledge shows to be desirable. Experiments have demonstrated that combinations of the cereal proteins with those of milk, meat, or eggs are much more efficient for promoting the growth of young animals, and for renewing the tissues of adults, than are the cereal proteins alone; and these are the very combinations which mankind eats whenever opportunity makes it possible.

Protein is decomposed in the process of digestion into fragments

called amino-acids. Nearly all proteins yield in varying proportion eighteen different amino-acids. In some proteins one or more of these may be absent. When new protein is required by the body, for the growth of the young or for the replacement of broken-down tissue in the adult, amino-acids derived from food are recombined into the protein of the new tissue. As the proteins of our food do not contain the same proportion or amount of the different amino-acids needed to construct the new-tissue proteins, there easily may be available too much or too little of any one of them. If any one amino-acid is furnished in too small quantity, then growth or repair will be retarded. The greater the quantity of protein eaten, and the greater the variety, the less danger there is of running short of the necessary quantity of any one essential amino-acid. Whatever surplus may remain is easily disposed of; so that the danger lies on the side of too little protein rather than too much. We must avoid too near an approach to the protein minimum in our diet until we know more about the chemistry of proteins and their true value in nutrition.. Our instinct assures us of a margin of safety which is doubtless wider than is necessary, but how much wider, no one knows.

It is not at all improbable that another feature is involved in the question of the protein minimum, for it may well be that the greater efficiency of the meat-eating nations, which has often been used as an argument against a low-protein regimen, may be thus explained. It has long been known that an increase in the amount of protein consumed above that needed to protect the body-tissues from loss of nitrogen is accompanied by an increase in the amount of heat given off by the animal. This occurs only when the protein eaten is greater in quantity than can readily be stored in the body cells. A similar increase in heat-output does not take place when carbohydrates or fats are eaten in quantities above those needed for maintenance. Rubner considered this extra production of heat to he peculiar to proteins, and called it their "specific dynamic action." He assumed that the activities of the body-cells as a whole were constant, and consequently required a constant supply of energy from the food to maintain their normal functions; and that any quantity of protein above what was needed for these normal functions was simply burned up with evolution of heat, but with no effect on the cellular metabolism.

Amino-acids resulting from the digestion of protein cause an extra evolution of heat when fed to animals. This has been interpreted by Lusk as due to a stimulation of metabolism, for the heat developed is greater than could be caused by combustion of the amino-acids supplied.

If protein stimulates metabolism, its effect on the well-being of an organism, especially of one so highly developed and sensitive as man, may well be very considerable. Under the influence of

this stimulus the output of work, both physical and mental, may easily be increased. Certainly the known relative efficiency of the meat-eating nations compared with the seed-eating nations of the Orient is not inconsistent with such a possibility. The efficiency frequently shown by men on experimental low-protein diets, which might be cited as evidence against this view, has often been attributed to psychological causes; for the enthusiasm of converts to new cults often leads them to most remarkable accomplishments.

Whatever the truth may be, the instinct of the great majority leads them away from a low-protein diet; and, in view of the many wonderful ways in which instinct saves us from nutritional disasters of other kinds, attention certainly ought to be given to the amount of protein which man instinctively eats when not restricted by available supplies, or by poverty.

IV

Reviewing our recently gained knowledge from the standpoint of one seeking information by which to regulate his own dietary habits, we find that the chemical requirements of nutrition can be met only by the use of a variety of food-products, and that instinct, which impels man to crave this variety, saves him under normal conditions from the dangers involved in a too-restricted choice.

Those of us who habitually eat an unduly large or unduly small proportion of any particular kind of food will do well to alter our habits in this respect, and conform more nearly to the practice of the average American, whose daily ration consists of about three and a half ounces of sugar, four and a half ounces of fat, eight and a half ounces of flour, and three and a half ounces of protein.

The widely different sources that may be drawn on for the protein in this ration permit the needed variety. Protein is furnished by milk, eggs, meat (including poultry and all kinds of sea-food), and, to a limited extent, by vegetables and fruits. Proteins from these different sources do not have equal value in nutrition, but instinct leads the normal man to eat the very combinations which science proves to be the best. Young rats in my laboratory grew very slowly when wheat-flour furnished all the protein of their diet; but when meat, milk, or eggs supplied one third and flour two thirds of the protein, they grew rapidly. Bread and milk, bread and meat (sandwiches), and eggs on toast are combinations evolved by human instinct long before science discovered a chemical explanation of their efficiency. Man's natural desire for a varied diet thus takes account of even the fine points of the chemistry of the proteins.

Lusk has recently published a long list of foods, natural and manufactured, with their retail prices, calculated on the basis of the amount of fuel they furnish to the body for the performance

of its daily work. It is curious to see how uniform these prices are for the foods which are eaten chiefly for their fuel-value. A higher, but fairly uniform, price is paid when protein is the chief factor furnished by the food. Far more costly than either of these are the vegetables and fruits which furnish very little that formerly was considered essential for nutrition. This is an impressive demonstration of the accuracy of man's instinctive judgment as to the relative values of the food-products he buys; and when we see how he has learned through instinct to combine the things he eats, and realize the underlying necessity that prompts his apparent extravagance, we cannot fail to be impressed by the very high price that he is willing to pay for vegetables and fruit.

Flour and meat contain relatively little, and sugar and fat contain none, of the vitamines which must be in every ration in sufficient amount, if life is to be sustained. The amount of vitamines contained in milk and eggs is too small to render it probable that they alone will supply enough when consumed in the amounts ordinarily eaten. That man does live and, in general, flourish on the kind of food he instinctively eats, demonstrates beyond question that the supply of vitamines in his usual diet is sufficient for his needs. The only conclusion to be drawn from this is that vegetables or fruits, probably both, supply this most important food-factor, and that for this vital need man is ready to pay a good round price.

At the present moment science can add very little definite information on this most important aspect of our food problem. Until investigations now in progress are completed, we can give only general advice. In the meantime, I believe that instinct is a safe guide, that it is prompting us to eat the kinds of food we should.

In general, we eat very nearly the amount of food that we really need. He who does hard physical work needs to eat more than does the sedentary brain-worker whose labor involves no expenditure of energy that must be supplied by extra food; and so he who works with his brain instinctively eats less than he who works with his muscles. The old belief that different foods were of widely different digestibility has yielded place to the knowledge that what was formerly called indigestion really arises from a failure to completely assimilate the full amount that has been digested. Some foods—sugar, for instance—are so concentrated and so readily digested that it is easy to overload our metabolic processes with the products of their digestion. The muscle-worker can more easily oxidize and dispose of a surplus of food than can the brain-worker. Both need, however, the same kind of food in differing proportions. The sedentary man needs proportionately less sugar, fat, and cereal products than does the muscle-worker.

We are now confronted by restricted supplies, and nearly all of us have been compelled to modify our dietary habits so that we are no longer protected by instinct. While the war lasts, we shall have to adjust our habits to conditions more and more. Already, what and how much we shall eat has become a very practical problem.

Science can help much in meeting this emergency; but, like every other agent which is being employed to win the war, it has its limitations. Unless dietitians fully realize the limits imposed by our present imperfect knowledge, and heed the lessons to be learned from instinct, we shall encounter, not only nutritional difficulties, but serious social discontent.

Fortunately the United States has a Food Administrator, surrounded by a body of expert advisers who are not only alive to all that science can do to aid them in dealing with their serious problems, but are also awake to the necessity of carefully considering the part played by instinct in the food-habits of the individual. Hard times are ahead of us, but we may be sure that such advice as the Food Administrator gives will be the best that any nation has had. No one will suffer in health or efficiency by following his directions. During the war, we must trust him. After the war, we must learn more about this important subject.

MIGRATIONS OF BIRDS[1]

Nature provides many ways by which the rigor of winter may be met by different living beings, few of which follow during this season the course of life pursued in summer.

Most of the quadrupeds hibernate in holes in the ground or in trees from which they rarely come for food until spring, spending the winter in sleep and slowly assimilating the substance of their bodies. The reptiles bury themselves in the ground or in mud beneath water, where they remain out of reach of frost in a state of helpless torpor. Many of the insects which live over the winter present a problem that was brought to my attention one day this winter. Although it is not connected with the subject of bird migration it may be of sufficient interest to consider for a moment.

One cold day in January, a wasp which had in some way become warmed up, crawled on to my laboratory table, having come probably from under the roof of the building. I at once wondered how, under ordinary circumstances, such an insect could find a place where it could pass the winter without freezing, and as I

[1]A paper read before the Friday Night Club, New Haven. This and the following paper are posthumous manuscripts published here to illustrate Dr. Osborne's interest in biological science.

could not believe this possible, I put the wasp into a small bottle with a thermometer and put it out of doors, where the thermometer, whose bulb touched the wasp, soon marked below 20° F. After leaving the wasp at this temperature for a couple of hours, much more than long enough to have frozen the entire bottle full of water, I took it out and, though at first apparently dead, in a few minutes it was flying about the room.

Now the question is, if its fluids were frozen and circulation thereby stopped, why was not vitality entirely suspended, and how, if this was so, could life be resumed on thawing out, unless vitality is nothing more than a chemical phenomenon? That is, given the proper chemical conditions, does not life follow as a consequence? But to return to our subject.

As you know, nearly all of the species of birds breeding in temperate regions go to the south in winter to escape the cold. Only forty-three species are recorded as resident throughout the year in this state and most of these are rare. Of the common species thus resident, by far the greater number of individuals go south in winter or north in summer. For instance, a very few robins and blue birds sometimes stay with us during the winter and a very few chickadees and nuthatches remain during the summer to breed.

What causes the birds that have gone south in winter, where they find plenty of food and comfortable weather, to start north at the approach of spring is a question that has caused much speculation on the part of ornithologists, but has never been satisfactorily explained. It cannot be that the conditions of life, at the south, become unsuitable, for individuals of a majority of the migratory species remain to breed far south of the northern limits to which others of the same species wander in their spring migration.

Many believe that sentiment is the main cause which prompts the bird to undertake the long journey,—in many cases more than a thousand miles—that the bird is impelled by an overpowering love for the home in which it was reared to return each year and renew the pleasant associations of the past. This seems to be an absurd explanation for, so far as I have observed, birds are absolutely devoid of sentiment and affection, their actions being wholly controlled by blind instinct. No birds seem to have more affection for their home, their mates or their young than domestic pigeons, but any one who has studied their habits can manage them in such a way as to make them do many things that an affection of this sort would render impossible.

The true motive leading to migration is an instinct which cannot be explained any more than those instincts which lead a human being to cry with pain or grief, and laugh with joy. It is simply a fact of nature that must be accepted as such. The

most striking feature of bird migration is the regularity with which it takes place, a regularity far greater than most people who have not kept annual records of the arrival of birds would realize.

The date at which the first individual of most species appears in the spring varies very little from year to year and is independent of the condition of the season, that is, whether the spring is early or late. Thus, I have noted the arrival of the first oriole for many years and have never known him to come before the fourth of May nor later than the ninth, while in the great majority of years I have seen the first one on the seventh. During these years I have kept a record of the first blossom on a particular cherry tree, which shows that the oriole arrives with a far greater regularity than the flower, the bird varying but five days while the flowers varied fourteen.

It seems at first thought surprising that birds should be so exceedingly regular in their movements, but I think this can be easily explained on purely physiological grounds. The period of gestation and of menstruation among all animals, even when domesticated, are extremely regular, recurring at perfectly definite periods for almost every individual of each species. With birds, definite periods of sexual activity exist for males as well as females, and it seems almost certain that, with the return of the sexual activity, the impulse to migrate develops and incites the bird to undertake the journey. We can thus understand how it happens that they arrive in the spring with such regularity, although we have no explanation of why this sexual activity should cause them to move north. As to the southward migration, this theory, of course, offers no aid, for there is no apparent reason why the bird should be impelled at a certain fixed time to start south when sexual activity ceases.

That each species leaves at nearly the same time in the fall is well established, but that they move with the same regularity as in the spring is not demonstrated. It is far easier to recognize the arrival of the first individual of each species in the spring than the departure of the last, or even of the majority, of a species in the fall. Further, as there must necessarily be many weak individuals remaining, who are unable to take long journeys, their presence would always cause uncertainty in regard to the actual date of fall migration.

Such evidence as we have, however, indicates pretty plainly that the fall migration is more leisurely than the spring, though the great bulk of it seems to take place within a few days. Every sportsman recognizes the fall flight of woodcock, which takes place about the first of November, during which a place that has been hunted thoroughly the night before and found destitute of woodcock may be full of them the next morning and almost any

other favorable spot will also abound with them. These flights last but three or four days, and often do not occur, the birds doubtless passing rapidly by and not stopping at all. Such was the case in this vicinity last fall, when almost no woodcock, except those raised about here, were shot by anyone.

In accord with the idea that the birds are started north by a return of sexual activity, we find in many species that the males precede the females by a week or more. Thus, while the meadows may be filled with red-winged blackbirds, one may search in vain for many days before a single female can be found.

During migration most species move at night, though in no sense nocturnal in their habits. Such include most of our smaller birds, as sparrows, warblers, thrushes, vireos, blackbirds and many others, while hawks, swallows, robins, ducks and others, go by day and some go indifferently by night or by day. That birds migrate at night has been proved in a variety of ways. Anyone interested in birds can hardly have failed to hear their calls at nigbt while passing overhead during the season for migration. In this way many species can be recognized by their notes. I have frequently interested myself, when trying to get to sleep, in listening to their calls and trying to identify them.

It is well to know that during migration large numbers of birds are attracted to and killed by flying against lighthouses. In this way much has been learned of their nocturnal movements. From the dead birds found about the lights it is evident that most, perhaps all, the species migrate in flocks of their own kind. Even those species which are never seen in flocks during the day associate in large numbers when they migrate. It is only in cloudy and thick weather that the migrating birds come to the lights, for on clear nights they evidently fly high.

Several interesting observations have been made regarding *their mode of travel* by *watching them with a telescope as they* pass across the face of the moon. At Princeton, Mr. Scott (October, 1880) saw a large number of birds through an astronomical telescope fly across the face of the moon at a height estimated to be from one to three miles. These birds passed at the rate of from four to five a minute. Among them many were recognized as warblers, woodpeckers and blackbirds.

Later, F. M. Chapman, also a well-known ornithologist, in three hours saw 262 thus fly across the face of the moon, at heights of from 1,500 to 15,000 feet. Five of these birds were Carolina rails, that were flying at a height of more than 2,000 feet above the earth. To one acquainted with these birds upon the marshes this seems a most extraordinary statement, for Carolina rails are rarely seen to fly at all unless driven from the grass at high tide by pushing a boat almost on top of them. When thus forced to fly, they spring up, fly heavily for a few rods and drop again

into the grass. Often it seems as if even this exertion were too much for them, and they so quickly drop upon the marsh as to make it nearly impossible to shoot them.

An interesting account of similar observations was published in the *Auk* by Libby, who watched the migration for three successive nights at Washburn Observatory, September 11, 12 and 13, 1897. During these observations, 583 birds were counted, 358 being seen on one night, and 45 passed during one period of 15 minutes. These observations indicated that the greatest number passed before midnight, and up to this time nearly all the birds were flying directly south. After this hour the direction varied much; birds passed in all directions, though two-thirds still flew south.

If one considers how small a portion of the air is under observation when looking in this manner at the moon, the number of birds that pass over the whole heavens above the United States will far exceed the number of wild pigeons about which you are so skeptical. That birds so small as were a very large proportion of those recognized, should thus fly thousands and thousands of feet up in the air when migrating, is most extraordinary, especially as most of the species noted fly but short distances by day, and seem incapable of sustained flight. It is possible that they find it easier to fly at first nearly perpendicularly until they have reached a great height and then, as it were, slide down hill to their destination. This is indicated by the apparent fact that their migrations high in the air take place early in the night, and that later they are seen flying in directions other than south as though looking for a suitable resting place. Such observations as we have upon the rate at which the migrating flocks advance also make this probable, for it would appear that the daily advance is much less than would be expected, if the birds ascended so high in order, afterwards, to follow a horizontal path.

Brewster has observed that small birds preparing to cross from Point Lepraux to Campobello, about twenty miles away, would mount upwards in a spiral until about 500 feet high and then take a direct course for their destination. This, however, may have been simply for the sake of getting to a better position from which they could see to follow their course.

In 1884 and 1885 an extended series of observations upon bird migration in the Mississippi valley were undertaken by the division of economic ornithology of the United States Department of Agriculture, a report of which was published by W. W. Cooke. A large number of observers were found who volunteered to keep uniform records of the arrival and departure of birds throughout the valley. At the same time meteorological records were carefully kept and weather maps made upon which the progress of the migrations and the condition of the weather were

recorded. The results of this study were not so valuable as might have been expected, apparently largely because many of the observers were either incompetent or had not sufficient time to watch the birds as closely as they should have done. One interesting point, however, seems to have been established, and that is that most of the smaller birds during the spring migration advanced only about 25 to 30 miles a day, a distance much smaller than I had supposed. It also appeared that the bulk of the migration took place when the barometer was falling and the wind was south. As the south wind usually rises when the barometer falls, the former condition was doubtless the chief factor. It was not demonstrated whether the direction of the wind or the warmer weather which usually accompanies a south wind was the cause of the northward movement. The bird migration weather maps showed that northern points were sometimes reached before other points to the south of them, since the birds followed the area of warmer weather with south winds, as it pushed its way north in a sort of peninsula with colder weather lying on both sides of it. These places to the east and west were afterwards filled by the birds coming into them from all sides.

How it is that birds find their way over such great distances is a matter of dispute among ornithologists. The only theory that has many adherents is that they are directed by sight, being guided by rivers, mountain chains and coast lines, which they have learned to follow by having passed over the country before, the young and inexperienced being guided by the older ones. In this country many of the well-known ornithologists hold this view, but in England and on the Continent it is not accepted. This disagreement is due to the fact that, in this country, observers believe that they have proved that most of the older birds go south first, but that enough remain behind to act as guides for the young, while in Europe the contrary is considered to be demonstrated. Of course if the young go first they cannot find the way by recognizing landmarks with which they are not familiar. It would be remarkable if European birds found their way south in a different manner from the American.

There is much in favor of the theory that birds are guided by the sight of natural objects. In the first place, carrier pigeons are believed by all familiar with them to be so guided, and it is necessary to train them for long flights by taking them gradually greater distances from home, and flying them over a course until they become familiar with it. In the second place, it is believed on what is considered good authority that river valleys, mountain ranges and coast lines form the main paths along which most of the migration takes place.

That migrating birds follow the coast, can be seen by anyone here in New Haven who takes the trouble to watch the migrating

birds day by day, especially in the fall. In October large numbers of hawks and swallows may frequently be seen passing, all moving west. It is a curious thing that large flocks, especially of hawks, are most often seen when the wind is strong from the northwest. At such times they force their way up into the wind and make evident efforts to avoid being blown to sea. It is supposed that they work up into the wind and fly along the coast well inland in order to avoid being blown out to sea. With a south wind, which might be supposed to blow them inland, they feel no danger and fly freely over the water.

Some think that in migrating birds are governed simply by a sense of direction and that, as savages have a more fully developed sense of direction than civilized men, birds may be still keener. As an illustration, which I have not seen given, but which seems to me a good one, the bee line made by the honey bee flying to its nest, might be mentioned. It does not seem probable that a bee finds its way by observing surrounding objects, but it gets there all the same.

It has been suggested that the magnetic pole in some unexplained way attracts them north, but those who have advanced this theory seem to have forgotten that they go south in the fall. They ought to have extended this theory by supposing that when in a condition of sexual activity they were magnetically attractive, but at other times repulsive.

THOUGHTS ON BIOCHEMISTRY[1]

A few weeks ago the Connecticut Agricultural Experiment Station celebrated the fiftieth anniversary of its founding and in the evening a dinner was given in honor of Dr. Jenkins, who had been Director of the Station for many years and a member of its staff from the beginning. At that dinner I sat next to Professor Johnston and had a very pleasant evening, probably chiefly because he let me do most of the talking. A few days later he came into my office and invited me to attend the exercises in this laboratory to-day. Why he did this to me I don't know, unless, on the basis that misery loves company, he wanted you to suffer as he had done. In reply to his invitation I read him an answer I had just that moment written to Professor H. C. Sherman of Columbia, who had invited me to deliver a lecture on proteins in a course of lectures to be given during the coming summer on "Modern Chemistry."

Even this letter did not get me out of my scrape because Professor Johnston insisted that it was my duty as a member of

[1] An unpublished paper read before the chemistry seminar at the Sterling Chemistry Laboratory of Yale University, New Haven, in November, 1925.

the faculty to take part in at least one university function before I retired. As he told me I might talk on any subject I might choose, I am going to say something about biochemistry, not because I know much about it, but because the experience of a lifetime in the laboratory has given me points of view which I find some chemists do not yet appreciate and which I want you as chemists to think about.

In the first place there ought to be no such thing as "biochemistry," for the problems which the biochemist deals with are in fact *chemical* problems, pure and simple. When I first began my work with proteins, there were no biochemists, those working in this field being called physiological chemists. This was due to the fact that practically all investigators of the chemical aspects of physiology were trained as physiologists primarily and as chemists incidentally. Most of them were not trained to think as chemists and had little appreciation of what the chemist regarded as proof of the chemical identity of the substances they isolated from plant or animal tissues. As a consequence the literature is filled with much that is worthless and much that is of doubtful value.

I remember that, early in my career, my father-in-law, Professor S. W. Johnson, who was the Director of our Experiment Station here, and one of the first professors of chemistry in the Sheffield Scientific School of Yale University, said to me that progress in physiological chemistry would not be made until *chemists* entered this field. This opinion was soon confirmed by Emil Fischer, who solved the problems of the purines, which up to that time had been in a state of confusion. Soon after, he did the same for the sugars and later did more than all others who had been working with proteins to give us an insight into the structure of these complicated molecules. Without question Emil Fischer was the greatest biochemist who ever lived and he was this because he was a great chemist. It is impossible to measure the extent of his contribution to biochemistry. Certainly not the least was the psychological effect produced among organic chemists. Before this time most organic chemists regarded the physiological chemist almost, if not quite, with contempt. They were poor dubs working with messes which rarely yielded crystalline products, and when they did, these poor fellows did not know enough chemistry to identify them. There was much to justify this attitude, but the fault did not lie so much with the physiological chemist as with the organic chemist who was too proud, or too lazy, to help solve the important problems of the chemistry of life.

I can well remember the superior attitude of most of my chemist friends during the early years of my work with proteins. It was not until Emil Fischer began his work in that field that they seemed to regard me as quite fit to associate with. Now what I

have said of biochemistry applies to all the other kinds of chemistry, organic, physical, inorganic, agricultural, immuno and the other various branches of chemistry. These are all chemistry, pure and simple, and none is wholly independent of the other; each needs contact with and help from the other, but none more so than biochemistry. In this field we have problems of every kind and of the most extraordinary complexity. Satisfactory progress cannot be made until all kinds of chemists unite in the attack.

The organic chemist can shut himself up in his laboratory and study single problems of structure, or synthesis, and succeed without the help of others. The physical chemist or the inorganic chemist can do likewise, but not so the biochemist; at every turn he meets new problems in the other fellow's field. He must be an intellectual phenomenon who can do much alone. The variety and profundity of the knowledge needed to cope properly with most of even the simple problems is greater than one man can have. Even keeping up with the literature of a limited field takes so much time that there is little left for the laboratory, to say nothing of golf or tennis.

The only escape from these difficulties, as I see it, lies in coöperation, not between individual biochemists, but between groups of real chemists. This is an age of specialists who are rapidly becoming more and more circumscribed in their fields. There is great danger in this, because contacts are becoming fewer and fewer when they ought to be becoming more frequent.

Now what I am coming to is this, that here at Yale we have an opportunity for coöperation in chemistry which could be utilized to great advantage in promoting biochemistry although this would not in any way impede the progress of the several departments in their own fields.

It is quite logical that an effective biochemical group be developed at Yale, for a beginning was made here before the Sheffield Scientific School was founded. As early as 1847, J. P. Norton, who came here to be a professor of chemistry in Benjamin Silliman's laboratory, was engaged in studying chemical problems of agricultural interest. Norton was a man of no mean ability and, had he not died as a young man, would have filled an important place in the history of biochemistry. He was followed by Professor S. W. Johnson who was trained by Erdmann, von Kobel, Liebig and other leading European chemists. Johnson's interest in chemistry was chiefly in its relation to agriculture and it was largely through his efforts that the first American agricultural experiment station was established in Connecticut. For several years the laboratories of this station were furnished by the Scientific School in South Sheffield Hall. Although Johnson would not be called an agricultural chemist, he was a true chemist in

every sense of the term. Chittenden, one of Johnson's pupils, for many years brought fame to Yale through his many researches in physiological chemistry. More recently Wheeler, Johnson (T. B.), Mendel, Underhill and Henderson have done their full share in maintaining the traditions of Yale in this field of science. This work is now being continued by the younger associates of these men with every promise that the high standards of the past will be maintained in the future.

You thus see that we have here at Yale a biochemical background continuing without a break for more than 75 years. A long time; for remember we have not yet celebrated the 100th anniversary of the first organic synthesis, Wöhler's production of urea being the first demonstration that a natural organic substance could be produced in the laboratory.

As an old man, I might be content with this recital of past achievements, but I am not yet too old to look forward to the possibilities of the future with more satisfaction than I do to the achievements of the past.

It seems to me that we have here in New Haven exceptional opportunities which have not yet been developed. We have a fine chemical laboratory equipped for work in all branches of pure chemistry, we have another laboratory in the Sterling Hall of Medicine equipped for work in biochemistry and we have a small laboratory at the Experiment Station with special equipment for work in protein chemistry. In these various laboratories we have men who are masters in their various fields, capable of conducting research of a high order of excellence. Heretofore all these laboratories have coöperated in a friendly spirit, but I do not think this coöperation has reached the limits of its efficiency. I recognize that each laboratory has its own problems in which it is especially interested and I do not suggest that anything should be considered which would interfere with work now in progress.

It has occurred to me that it might be possible for us all to get together some time and see what might be done to help each other. A beginning might be made in arranging the subjects for theses of some of the graduate students so that their work might fit into a scheme which, as it developed, would contribute to the solution of some of the problems which are already the subject of continuing investigations. Thus in my own field there are many lines which we are unable to deal with, both through lack of knowledge and experience, as well as through lack of facilities and personnel.

For example, we greatly need to know the physical constants of the amino-acids. We can make reasonable quantities of several of these, but we are not in a position to study them properly. We cannot expect the department of physical chemistry to undertake such investigations unless a suitable supply of amino-acids is available. Might it not be possible to give one or more grad-

uate students a problem in this field and let us supply him with material and help him in any way we can with such knowledge and experience as we may have? I believe that if a student had a problem of this kind which he knew might yield results of definite use to those working in protein chemistry, he would be more interested in it than if he had a problem of only general interest. Furthermore it would bring him in contact with those working along lines quite different from those he encounters in the laboratory of physical chemistry, and so give him a fuller realization of the importance of his work. In this way some good physical chemists might get interested in the biological field, in which there are a multitude of problems for them to study.

In a similar way we need to know much that the organic chemist can find out for us. Very little work has been done with most of the amino-acids and here is a large field in which the organic chemist can do most useful work. In our attempts to separate quantitatively the products of hydrolysis of proteins we are constantly blocked by a lack of knowledge of properties of the various amino-acids. Now that most of these products are known qualitatively, it ought to be possible to make derivatives which would enable us to estimate quantitatively some of them more accurately than is now possible. As an example, if we could find a way to separate leucine and phenylalanine, or to estimate phenylalanine in a mixture of these two amino-acids, the whole process of analysis could be greatly simplified. Also the oxyamino-acids present difficulties which I feel sure a better knowledge of their properties would do much to overcome. Serine, oxyproline and oxyglutaminic acid are important constituents of many proteins, but these have been so little studied that at present we have no means for determining, even in the crudest way, the amount of any one of these yielded by a protein. From this you can easily appreciate that there is a great deal of purely chemical work to be done by the organic chemist before the biochemist is in a position to do what he is now attempting to.

Beside the chemical questions which group themselves about the proteins, there are multitudes of others which concern the environment in which the protein exists within the living cell. Although physiologists have long been interested in this subject, almost nothing supported by chemical evidence has been learned. After the necessity in nutrition of those substances now called vitamines was recognized, it became important to know more about the soluble constituents of living cells, because some of these are the so-called vitamines. Having been attracted to this subject by the need of preparations for feeding which would introduce into the diet as little as possible of constituents of unknown nature, I was soon brought face to face with the problem of cell chemistry. This same problem was presented from another side when

we attempted to isolate protein from green leaves. In this work we found it possible to obtain the juice of the leaves free from all of the formed elements which seemingly exist in a colloidal state, presumably for the most part protoplasm. Since, for several reasons, we wanted to know the nature of the substances present in this juice, our laboratory undertook to apply available methods for isolating definite substances from it. While an enormous number of well-defined substances have been isolated from one plant or another, apparently no one has ever attempted to get even an approximate idea of the relative proportions of the various groups of compounds which might be present in a single plant. The same applies equally to animal tissues. In other words we have at present almost no knowledge of cell chemistry, the very foundation of both plant and animal physiology.

For the past three or four years we have been working at this subject, applying all the available methods with astonishingly little success; a result we foresaw, because we looked at the problem from a purely chemical standpoint and realized the difficulties to be encountered. One immediate aim, however, was to demonstrate to those of our fellow workers, especially in the experiment stations, how futile it usually is to continue making so-called analyses by indirect methods supposed to show the chemical nature of the materials analyzed, when in fact they furnish no evidence whatever that a real chemist would consider for a moment. I call our work from this aspect a fool-killing research, from which, if nothing else results than the saving of time and money at present going into the accumulation of comparatively worthless data, I feel that our work will be worth all it costs. However, I am much more hopeful than this, because I have a firm faith that good work in a field of such importance to science cannot help but prove to be of ultimate value. We also hoped that when our results demonstrated how appallingly little is known of the constituents of cells, other chemists might be stimulated to help us. I think that Professor T. B. Johnson appreciates this point of view, because in his work with the chemistry of the tubercle bacillus he has encountered the same difficulties.

Until a beginning has been made to explore such fields, the nature of the problems in organic and physical chemistry which must be studied will never be appreciated. The kind of work needed requires men of special training, each in his own field, but with contacts with each other that will not only make their efforts effective, but interesting and inspiring.

The biochemist, that is, the chemist who does this pioneer work of exploration, seldom has the technical experience to deal as successfully with his many problems as those who are trained along narrower lines. He has so many kinds of questions to struggle with that he is usually a Jack-of-all-trades and master

of none. He needs the sympathetic help of specialists, not their contempt, which in the past has so frequently been accorded him.

In concluding my appeal for help I want you to understand that I am not addressing it to the heads of the departments, or to the professors and instructors only, but to the students as well. Unless the student is interested, little in the way of coöperation can be expected, for those participating must have a real interest in the work. If the student is really interested he can force a reluctant professor to aid him in attaining his ambition far more easily than the professor can force a reluctant student.

Just how coöperation can be secured remains to be determined. My idea is that at first one or more students might be given some of the simpler problems for their thesis work. The experience which the student gains will inevitably be shared by his instructor who, another year, may find himself in a better position to direct the work of other students. In this way it seems to me that a mutual interest in each other's work will develop between the different professors and instructors and that these will cause a bond of union in their work which will do much not only to stimulate research in the department of chemistry, but to contribute to the application of chemistry to biology.

There are two aspects of engaging in coöperative work of this kind that deserve consideration. First, the relation of such research work to the future career of the student. For the organic chemist and doubtless also for the physical chemist some of the simpler problems may be just as good as any other as far as giving him experience is concerned. If his ambition is to specialize later along biochemical lines, either as a teacher of premedical courses or in medical schools, such a subject is eminently suitable. There are, however, relatively few positions in this field which offer inviting possibilities of reward, hence the student who specializes too narrowly in such work runs some risk of disappointment. There is an increasing demand in research institutes and medical schools for men who are capable of doing good work and perhaps the chance of success for such men as are really competent is as good as in any other field of scientific research.

This brings us to the second consideration, namely, what provision can be made for the post Ph.D. student who attempts such work? Good research work on many of the most important biochemical problems will not allow much, if any, time for teaching or the other duties for which the new fledged Ph.D. is usually paid. I believe that if a start can be made with graduate students working on biochemical subjects which contribute to the progress of some major continuing investigation, it will be possible to secure funds sufficient properly to endow fellowships and to support their work. If we here at Yale are in a position to demonstrate

that the appointees to such fellowships can make good, I do not believe it will be hard to secure the necessary funds. My own experience has been that financial support followed accomplishments about as fast as I was in a proper position to receive it.

NOTES ON THE NEST BUILDING HABITS OF THE PIPE ORGAN WASP[1]

The nest consisting of three tubes cemented together is a part of one of originally five tubes, two of which were broken when removed from a partition in a stable at Washington, Conn., about August 22, 1916. This was fastened to a smooth board in a nearly vertical position with the opening downwards, as indicated in the drawing. About three feet away another nest was being built. When first noticed, this was about one inch long, at 11 A. M. Two wasps were engaged in constructing this nest. One, smaller than the other, and apparently browner in color, was inside; the other, black with a blue lustre, worked on the outside, collecting clay and putting each portion in place. The clay was brought moulded into a strip about three-fourths inch long and one-sixteenth inch in diameter. This strip, as near as I could see, was carried on the front leg and held by one end with the jaws. This end was applied to the crotch at the median line of the nest and then rapidly attached to the edge of the piece which had previously been put in place. Apparently it was moulded by the jaws and pressed into position until the end of the strip reached the end of the preceding portion and there came into contact with the board to which the nest was attached. The end was then flattened out against the board, the jaws and fore feet being used to make it adhere firmly. During this process, the wasp inside made a buzzing sound and seemed to be engaged in maintaining a proper sized bore for the tube under construction. When the clay was attached the larger wasp went inside the tube and the two set up a loud buzzing for a few seconds. It then came out and flew away to return after two or three minutes with another strip of

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[1] During the summer of 1916, Dr. Osborne, head of the Department of Biochemistry of this Station, spent his vacation in Washington, Conn., and became interested in watching some mud wasps construct their nest on a board of the barn. On returning to New Haven he brought me one of the wasps, the nests, and the notes and said that I might use them in any way I saw fit. The wasp was identified by Dr. H. T. Fernald, Amherst, Mass., as *Trypoxylon albitarse* Fabr. (male). The nests were provisioned with spiders which were sent to Mr. J. H. Emerton, Boston, Mass., who reported as follows: "The spiders from wasps nests are all *Epeira trivittata* Keyserling, all females, and half of them adults. They make round webs and live in the tall grass and bushes all over the country." W. E. Britton.

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clay which was put in place on the opposite edge of the opening of the nest. This process was continued. Each time the outside wasp returned it struck the wall about three or four feet from the nest, but located the nest after a few seconds by flying about on one side or the other, coming gradually nearer each time as though attracted to it by some invisible force. After every four or five trips by the outside wasp the inside wasp would come out and fly away. *When it returned it struck the wall much further* away than did the outside wasp and had more difficulty in finding the nest. Whether or not it brought anything with it I could not see. At any rate, whatever it carried was very small. On returning, this wasp went directly into the nest and stayed there until the outside wasp had put three or four more strips of clay in place. I did not see the first tube finished or the second tube begun for I had to go away when the former was about two inches long. About 9 A. M. the next morning the first tube was approximately three inches long and a second tube had been made which was about one and a half inches long when I first saw it. I watched the construction of the second tube until 11 A. M. when it was as long as the first. When it reached this length the inside wasp set up a very loud buzzing when the outside wasp came back with more clay and apparently made such a fuss that it did not dare attempt to put the clay in place. After attempting several times to do so the outside wasp flew off with the clay and came back again, after a few minutes, apparently without any clay and went inside the nest. It then made regular trips coming back with such small quantities of clay that I was unable to see that it carried anything. When it entered the nest, clay must have been brought because after several trips a partition had been built across the lower end of the tube. I did not see any spiders put into the tube before the partition was completed, but I did not watch them continuously and this may have been done while I was away or it may have been done during the trips of the inside wasp, but I think I would have seen the spider when it came back to the nest if it brought any. A heavy thunder shower put an end to the work for the day. The next day, no more work seemed to be done and the outside wasp was not seen. One, or both, were in the nest in the afternoon as evidenced by the buzzing which followed on putting a straw into the tube. The tube first made had a partition about one-half inch from its mouth. It probably had two others lower down. Both tubes were attached to the wall in a vertical position with the mouth opening downwards.

HONORS AND MEMBERSHIPS

THE GOLD MEDAL OF THE PARIS EXPOSITION, 1900

In 1900 Dr. Osborne sent a number of preparations of seed proteins to the Paris Exposition. He received a gold medal with the following diploma.

RÉPUBLIQUE FRANÇAISE

MINISTÈRE DU COMMERCE, DE L'INDUSTRIE, DES POSTES ET DES TÉLÉGRAPHES

EXPOSITION UNIVERSELLE DE 1900

LE JURY INTERNATIONAL DES RÉCOMPENSES DÉCERNE UN DIPLÔME DE

MÉDAILLE D'OR

à Monsieur *T. B. OSBORNE*, STATION AGRONOMIQUE DE CONNECTICUT, À NEWHAVEN

GROUPE VII.—CLASSE 38. ETATS-UNIS.

LE COMMISSAIRE GÉNÉRAL
A. Picard

LE MINISTRE DU COMMERCE, DE L'INDUSTRIE, DES POSTES ET DES TÉLÉGRAPHES
A. Millerand

PARIS, LE 18 AOÛT 1900

HONORARY DEGREE FROM YALE UNIVERSITY

The degree of Doctor of Science *honoris causa* was awarded to Dr. Osborne on June 22, 1910. The presentation by the Public Orator was made in the following words:

"It is wholly a New Haven life which is honored in Dr. Osborne. Here he was born, here he was educated, and here for twenty-four years, as chemist at the Connecticut Agricultural Station, he has patiently carried on those laborious and minutely exacting studies on the albuminous constituents of plant forms and the chemical structure of the proteins which have received the support of the Carnegie Institution and found wide recognition

both in America and Europe. He sacrificed the certainty of large financial gains for a secluded life spent with rare devotion in the solution of the most intricate and difficult scientific problems. His success has brought no pecuniary rewards and little public heralding, but is all the more genuine. An honorary degree cannot restore to him the library, the laboratory equipment, or the invaluable preparations which perished in the recent fire at the Station; but it can assure him that his University, his teachers and his townsmen are proud of him."

HONORARY FELLOWSHIP OF THE CHEMICAL SOCIETY

In March, 1912, Dr. Osborne received the following communication:

CHEMICAL SOCIETY

BURLINGTON HOUSE,
Piccadilly, London W.,
March 7th, 1912.

SIR,

I have the honour to inform you that at a meeting of the Chemical Society held this day you were elected an Honorary and Foreign Member of that Body.

I have the honour to be, Sir,

Your Obedient Servant,

ARTHUR W. CROSSLEY,
Honorary Secretary

To
Dr. Thomas Burr Osborne
Newhaven (Conn.)

THE JOHN SCOTT MEDAL

At a meeting of the Board of Directors of City Trusts (Philadelphia) held March 8, 1922, the following resolution was adopted:

Resolved—Upon the recommendation of the Advisory Committee, that the John Scott Medal and Certificate, with Premium of $800, be awarded to Thomas B. Osborne, for "his researches on the constitution of the vegetable proteins."

HISTORY OF THE MEDAL

The John Scott Medal Fund was established under the will of John Scott of Edinburgh, Scotland, and is administered under a

Power of Attorney dated April 2, 1816. The will contains the provision that ". . . . the interests and dividends . . . . be laid out in premiums to be distributed among ingenious men and women who make useful inventions; but no one of such premiums to exceed twenty dollars, and along with which shall be given a copper medal with this inscription 'To the most deserving.' "

A decree of the Court of Common Pleas of Philadelphia states: "And now, this nineteenth day of February, A.D. 1919, the Report of the Master having been duly filed and no exceptions having been taken thereto, it is adjudged and decreed that the same be confirmed, and that the Board of Directors of City Trusts, having in charge the Trust created under the will of John Scott, deceased, be authorized and directed in the administration of said Fund to distribute the income arising from the Fund as it stands with its accumulations as of the date of this Decree, in premiums to be distributed among ingenious men and women who make useful inventions, but no one of such premiums to exceed Eight Hundred Dollars ($800.00) in value; and along with such premium shall be given a copper medal with this inscription 'To the most deserving' conformably to the tenor of the Will of the said Testator.

"It is further ordered and decreed that in the selection of the recipients, the said Trustees shall be at liberty to make such rules and regulations for enabling them to make a wise selection of beneficiaries either by the selection of an advisory board or otherwise, as they may deem best. The premiums shall be awarded for useful inventions which shall include any inventions that will be useful to mankind in the advancement of chemical, medical or any other science or in the development of industry in any form; the test being that the invention is, in the judgment of the Trustees, definitely accomplished, and that it may add to the comfort, welfare, and happiness of mankind."

A resolution adopted by the Board of Directors of City Trusts states:

Resolved—That the award of medals under the John Scott Medal Fund be made hereafter upon the recommendation of an Advisory Board, to consist of five persons, to be appointed by the Board of Directors of City Trusts; three to be nominated by the National Academy of Sciences, one by the University of Pennsylvania, and one by the American Philosophical Society.

This Advisory Committee is constituted as follows:

National Academy of Sciences—H. H. Donaldson, Theobald Smith, W. B. Scott;

University of Pennsylvania—Arthur W. Goodspeed;

American Philosophical Society—Samuel M. Vauclain.

THE THOMAS BURR OSBORNE MEDAL

ADDRESS OF THE PRESIDENT OF THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS AT THE PRESENTATION OF THE THOMAS BURR OSBORNE MEDAL
JUNE 7, 1928

It has long been the desire of many of the members of the American Association of Cereal Chemists to honor those scientists who have contributed signally to the advancement of our knowledge in this field of specialization. This desire took definite form at the time of the 1926 convention in Denver when President Clark proposed in his presidential address that provision be made for the presentation of a medal to be periodically awarded to those who contribute unusual papers based upon cereal chemistry research. The association referred this recommendation to the executive committee which was empowered to outline a plan and make the other necessary arrangements for the award of such a medal. The executive committee gave careful attention to this new and important project and it was decided that rather than award such a medal at regular stated intervals, the award be made only at such times as were justified by unusually meritorious contribution. The president of the association was requested to appoint a jury of awards whose duty it should be to scrutinize the development in cereal chemistry and select the medalists. The promulgation of rules governing the basis on which awards are to be made was delegated to this jury, and in all matters respecting the medal their decision was to be final.

Basing his action upon the recommendations of the executive committee, President Clark appointed the following jury of awards:

Dr. Carl L. Alsberg, Chairman, The Food Research Institute, Stanford University, California,

A. W. Alcock, Western Canada Flour Mills Co., Ltd., Winnipeg, Canada,

Dr. R. A. Gortner, University of Minnesota, University Farm, St. Paul, Minnesota,

Paul Logue, The Provident Chemical Works, St. Louis, Missouri,

Washington Platt, The Merrell-Soule Co., Syracuse, New York.

The executive committee also decided that it would be appropriate to name this medal in honor of some well-known American chemist who had made notable contributions to cereal chemistry. The jury of awards took this recommendation under advisement and later requested of Dr. Thomas Burr Osborne the privilege of naming the medal in his honor. Dr. Osborne very graciously acceded to this request with the result that this medal will be known for all time as the Thomas Burr Osborne medal.

Later the jury selected Dr. Osborne to be the first recipient of the medal which has been named in his honor. This happy selection has very evidently proved acceptable to the members of the Association.

Dr. Alsberg, chairman of the jury of awards, engaged an artist to prepare the design of the medal. From this design the necessary dies were manufactured under Dr. Alsberg's direction. The medal bears the medallion portrait of Dr. Osborne in low relief on the obverse, and a suitable inscription on the reverse. In notifying Dr. Osborne that this medal had been awarded to him, he was cordially invited to attend this convention at Minneapolis as a guest of our Association, but to our regret he was forced to decline the invitation because of ill health. He designated as a proxy to represent him on this occasion, Dr. Carl L. Alsberg, who accordingly has come here to-day as the personal representative of Dr. Osborne.

Dr. Alsberg, will you please come forward. In behalf of The American Association of Cereal Chemists I take great pleasure in handing you this gold medal which you in turn will present to Dr. Osborne with our best wishes.

LESLIE R. OLSEN.

ACCEPTANCE OF THE MEDAL

Mr. President and Members of the American Association of Cereal Chemists.

I greatly regret that conditions are such that I must delegate to another the acceptance of the medal with which you have honored me. This recognition from your Association is particularly gratifying to me in view of the almost total lack of recognition my work received during the many years in which I was chiefly occupied in studying the proteins of the cereals. If it had not been for the warm support of Professor S. W. Johnson, then director of the Connecticut Agricultural Experiment Station, and that of the later director, E. H. Jenkins, as well as my own firm conviction that anything that could be learned about the chemistry of cereals was important, I am quite sure I should have been discouraged. During those years none of my fellow chemists seemed to take any interest in my work; in fact many of them intimated pretty plainly that I was wasting my time working in a hopeless field. Consequently you can realize that I am greatly pleased to find that, as my active life is closing, your Association thinks that what I have done is so well worth while as not only to deserve a gold medal, but one named after me, and of which I am the first recipient. Gentlemen, I thank you.

As I contrast the conditions prevailing in agricultural chemistry today with those prevailing at the time I first began to work

with cereals, and realize that now the workers in cereal chemistry alone are sufficiently numerous to form your relatively large Association, I can hardly believe that this has all come to pass. When my first papers on the vegetable proteins were written, we did not dare print them in the reports of the Connecticut Agricultural Experiment Station lest, when the question of our appropriation should come up, some witty member of the legislature should ridicule the papers and their author on the ground that there was no apparently practical application of the results that would be useful to the farmer. Those first papers were published in the *American Chemical Journal,* edited by Ira Remsen. After he had received three or four of them he plainly intimated that more would not be received with joy. Then I sent the next to the *Journal of the American Chemical Society,* which accepted it with some signs of appreciation. This encouraged me and I continued to publish there until the *Journal of Biological Chemistry* was founded. Since then my papers have appeared in this publication.

It is interesting to recall that the first real signs of appreciation of this line of work came from Germany, where all of the papers which I had printed during several years were gathered together, translated into German and published in a volume. After that it was much easier to carry on, and more and more chemists became interested in this work. I must confess that I had not found it easy to be working in such an isolated field and the reception of some recognition was decidedly helpful. Looking back to this beginning, you can readily see how gratifying it is to me to receive this medal today.

I have no recently completed research to offer you, according to the custom on occasions like this. Instead, I wish to call your attention to some present-day problems in the work you are engaged in. Under conditions prevailing today it is far easier to devote oneself to research in a field that offers little promise of immediate practical application than it was when I began, and I therefore hope that what I have said of my experience will inspire other workers to take up new lines of work with the confident expectation that whatever may be learned and definitely established in regard to the chemistry of cereals cannot fail sooner or later to be of use and to be worth all that it costs in time and money. When I see in how many different directions the results of the work which I started have been applied, I am astonished. Many of these applications have been in fields in which these results could not have been expected to be of any use. This is particularly true in their application to problems in medical science. In fact for many years men engaged in research in the biological sciences were the first to make real use of my work, and I found myself better known among biologists and physicians than among agricultural chemists.

In the field of cereal chemistry there are still many problems awaiting investigation. With modern facilities in experiment stations, research institutions and universities, and improved apparatus and available funds, it ought to be possible to learn much that will be useful and of broad application. We do not yet know by any means as much about the proteins of the cereals as we ought to know. This is particularly true of wheat gluten.

The nitrogen content of thoroughly washed gluten indicates a larger proportion of non-protein substance than has as yet been accounted for. It is possible that a part of this may be combined with protein as a compound neither basic or acid, and hence not soluble in either dilute acids or alkalies. That such a protein complex may occur in the seeds of cereals is indicated by the relatively small proportion of the nitrogen which can be brought into a clear solution with alkalies. We have heretofore assumed that the protein precipitated by neutralizing such a solution made from wheat gluten represents the whole of the protein insoluble in alcohol which has been designated wheat glutelin, but that such is the case has, by no means, been proved.

My former colleague, Dr. D. B. Jones, has recently made a study of the glutelins in several of the cereals and has obtained such small yields of purified preparations that it seems hardly credible that these represent all of the residual nitrogen, unless a very considerable part of the protein of the cereals exists in some such combination as I have suggested.

It ought to be possible to get some evidence as to the approximate proportion of the residual protein nitrogen by properly conducted hydrolyses. Heretofore, when studying proteins we have all tried, as far as possible, to avoid causing any changes in them through the action of reagents. Here we seem to have a case where perhaps we could learn something by the opposite procedure. Now that we know so much about the products of hydrolysis of proteins it is possible that we might get some good indirect evidence as to how much of the relatively insoluble nitrogen may belong to protein by studying these products. Through such a procedure we might learn something more about those proteins of which we now know so little.

The first cereal with which I worked was the oat kernel and I have long wished that someone would explain the unusual behavior of the proteins of this seed. In all my experience I have never found a seed containing proteins behaving towards solvents as these do.

Proteins are by no means the only constituents of cereals that are important. Now that we know the part played in nutrition by insignificant quantities of the so-called vitamines, we must isolate and chemically define every possible constituent of the cereals. Those of you connected with the industries may have

exceptionally good facilities to procure material for special studies that is better than any heretofore obtainable.

The embryos of wheat and corn are full of all kinds of things the nature of which is little known. These two products afford opportunity for chemical research of the highest order and both scientific and practical importance. Your Association of Cereal Chemists is in a position to promote such investigations successfully. In these days of modern science coöperation is essential. It is no longer possible in such a field as yours for one man to work alone effectively. Cereal chemistry involves far more than one would at first suppose, for not only are carbohydrates, proteins, fats and inorganic salts included in this field but also many other groups of substances which occur in smaller proportions.

The importance of a knowledge of the chemistry of these minor constituents of our food has only recently been appreciated. What is it in the wheat germ that renders an animal fertile which would otherwise be sterile? Why is the commercial wheat germ meal rich in the so-called vitamine B, while the pure germ appears to be practically destitute of this essential food factor?

Here are only two of the many problems that the cereal chemist has before him and these have not only scientific, but practical importance. To solve these problems requires the coöperation of many among you who have exceptional opportunities both in chemical training and mechanical facilities.

Chemists have done much for the industries and it is now time that the industries should appreciate this and be generous in paying their debt.

Gentlemen, I again thank you for the honor you have done me and congratulate you on the opportunities that lie before you for important contributions to science and industry.

T. B. OSBORNE.

MEMBERSHIPS

Dr. Osborne was a member or a fellow of the following learned societies:

American Chemical Society,
American Physiological Society,
American Society of Biological Chemists,
Society for Experimental Biology and Medicine,
National Academy of Sciences,
The Chemical Society,
American Academy of Arts and Sciences,
American Association for the Advancement of Science,
Société Royale des Sciences Médicale et Naturelles de Bruxelles,
American Philosophical Society,
Die kaiserlich deutsche Akademie der Naturforscher zu Halle,
Sigma Xi.

RETIREMENT

LETTER FROM THE STATION STAFF

Dr. Osborne retired from the active direction of the Biochemical Laboratory of the Connecticut Agricultural Experiment Station on June 30, 1928. The following action was taken by the Station staff:

Dr. Thomas B. Osborne,
Connecticut Agricultural Experiment Station,
New Haven, Conn.

Dear Doctor Osborne:

We have recently learned of your expressed desire to be relieved of active direction of the Department of Biochemistry and to continue service in the capacity of Consulting Biochemist. This we understand has now been arranged.

Since this arrangement does not remove you from our midst, but merely marks a change from one form of activity to another, it does not greatly disturb us. But it does give us an opportunity to express our appreciation of your brilliant career in your chosen field of endeavor. We are proud of your long record of outstanding scientific achievement and of your fine example of devoted public service.

But we are moved by feelings far deeper than those of mere pride in your success. Above all we cherish that friendship which has grown up between us and endured so long; and we rejoice in the prospect of a long continuance of those personal contacts which have been so uniformly pleasant in the past. We hold you in our admiration for what you have done, and in our esteem for what you are.

You have our best wishes for complete enjoyment of that leisure which you richly deserve and which lightened responsibility will bring.

Very sincerely yours,

YOUR FRIENDS AND COLLEAGUES ON
THE STATION STAFF

October, 1928.

MINUTE OF THE BOARD OF CONTROL

In the retirement of Thomas Burr Osborne from active charge of the Biochemical Laboratory, the Connecticut Agricultural Experiment Station loses one of the ablest and most valued members of its Staff.

In the forty-two years which he has served on the Staff, he has won distinction for himself and the Station, and he is today one of the acknowledged leaders in his chosen fields of study, the structure of proteins and the newer aspects of nutrition. His mind has always been raising questions which he was able to define with rare precision and then with equal discernment he has devised means for their experimental investigation and solution.

The members of the Board, in testimony of their recognition of his valued services, of their respect for his abilities, and of their high personal esteem, enter on their records this minute of their hearty appreciation. The members of the Board further rejoice that from time to time the Station may still have the benefit of his personal suggestions and advice.

G. A. Hopson,
Secretary.

Adopted by the Board
October 25, 1928.

OBITUARIES

MINUTE ADOPTED BY THE STATION COUNCIL

The death of Dr. Thomas Burr Osborne on January 29 brought deep sorrow to his friends and colleagues on the Station staff. Identified with this Station during all of his long and productive career, his conspicuous achievements in a difficult field have reflected great credit upon this institution which he has served so well.

In 1889 at the suggestion of Professor Samuel W. Johnson, then Director of the Station, he undertook a study of the nitrogenous substances contained in the kernels of oats. This marked the beginning of an intensive and sustained study of vegetable proteins which was to become the major project of his life work. For almost forty years he devoted his creative genius, his analytical skill and his powers of critical interpretation to the intricate problems of protein chemistry and of animal nutrition. Two hundred and forty-nine published papers and monographs, many of them of a pioneer character, represent the fruits of his labours. This vast and important work from the time of its humble beginning to its brilliant conclusion was pursued in all modesty and in keeping with the best traditions of unselfish public service.

Abundant recognition of his substantial contributions to the advancement of scientific knowledge has come to him and to the Station at the hands of colleagues in his own field of endeavor, both at home and abroad; and it is most gratifying to us all that these testimonials came while he could enjoy them as he deserved to do.

We who have been associated with him in his active service do not fail to appreciate his scientific worth; but above that comes our deeper sense of personal loss born of years of pleasant associations and of our esteem for the many admirable qualities of the man.

February 4, 1929.

CARNEGIE INSTITUTION OF WASHINGTON

REPORT OF THE PRESIDENT[1]

Through the death of Thomas B. Osborne on January 29, 1929, the Institution loses one of its most distinguished associates in research. Dr. Osborne was connected with work of the Institution from May 1902 until his retirement from active investigation

[1] *Reprinted from Year Book No. 28, 2 (1929) by permission.*

in July 1928. He was a pioneer in the development of our knowledge of the chemistry of the cell, and the nature and nutritive properties of vegetable proteins.

The thoroughness with which Dr. Osborne and his associates carried on their investigations brought results of exceptional scientific value. His accomplishments greatly advanced the scope and improved the methods of biochemistry and laid foundations for the important work now being continued by Dr. Lafayette Mendel and Dr. Hubert Bradford Vickery.

It is interesting to note that the studies through which Dr. Osborne and his colleagues have so ably advanced physiological chemistry have now direct relation to the biochemical investigations included in the program of the newly organized Division of Plant Biology.

JOURNAL OF BIOLOGICAL CHEMISTRY[1]

We regret to record the death, on January 29th, 1929, of Thomas Burr Osborne who was associated in an advisory editorial relationship with *The Journal of Biological Chemistry* since its foundation in 1906 and became a member of the Editorial Committee when the latter assumed responsibility for the general conduct of the Journal.

Dr. Osborne was born in New Haven, Connecticut, on August 5th, 1859, the son of Arthur D. Osborne (B.A., Yale 1848) and Frances Louisa Blake Osborne, daughter of Eli Whitney Blake, of New Haven. Thomas B. Osborne was prepared for college in the Hopkins Grammar School, and was graduated from Yale College with the degree of B.A. in 1881. He received the degree of Ph.D. from Yale in 1885, after having pursued postgraduate studies in chemistry there. The honorary degree of Doctor of Science was conferred upon him by his Alma Mater in 1910.

Dr. Osborne's earliest activities in the academic field were in the domain of analytical chemistry. He became a member of the Research Staff of the Connecticut Agricultural Experiment Station at New Haven in May, 1886, continuing active association therewith until his retirement last year. Throughout his long scientific career Dr. Osborne retained his affiliation with the Connecticut Station, during most of this period being in charge of a laboratory specially devoted to his own research interests.

Dr. Osborne's name will long remain associated with his pioneer investigations of proteins of plant origin. The first contribution (1890), dealing with the albuminous components of the oat kernel, was followed in rapid succession by a series of related studies which were summarized in his classic monograph on

[1] Reprinted from 81 (1929) by permission of the editor.

The Vegetable Proteins, in 1909. A revised edition appeared in 1924. The descriptive consideration of a large group of plant proteins was followed by investigations of the amino-acid derivatives of various purified proteins. Presently Dr. Osborne enlarged the scope of his research interests to include the biological properties of these substances. In collaboration with Lafayette B. Mendel and with continued generous support of the Carnegie Institution of Washington, of which he was a Research Associate since 1904, he directed some of his energies to the problems of nutrition, from 1910 until the time of his death.

During his scientific career Dr. Osborne published 253 papers and monographs, most of which deal with proteins and their derivatives. He was appointed a Research Associate of Yale University with professorial rank in 1923.

Recognition came to him from many sources through election to learned societies and through the award of medals for scientific distinction. The soundness of his chemical work was recognized by his election as an Honorary Fellow of the Chemical Society of London. Within the past year the American Association of Cereal Chemists instituted the periodical award of the Thomas Burr Osborne medal for distinction in the field of cereal chemistry research, Dr. Osborne himself being the first recipient.

Those who were privileged to enjoy a personal acquaintance with Dr. Osborne soon learned to appreciate his many sterling qualities as a man. An unusual enthusiasm for research which exhibited itself in more than one field of human inquiry; never-failing patience in the execution of experimental work; rigorous critique applied to his own results as well as the work of others; vigorous opposition to sham in any form; rare appreciation of the best contributions to science and industry; delightful companionship and deep loyalty to his friends—these were some of the characteristics of our respected colleague.

MINUTE ADOPTED BY THE BOARD OF DIRECTORS OF THE SECOND NATIONAL BANK OF NEW HAVEN[1]

It is with great sorrow that we record in our minutes the death of Thomas Burr Osborne, a member of this Board, which occurred at his home in New Haven on January 29th, 1929.

Dr. Osborne's grandfather, Judge Thomas B. Osborne, was a director of this bank from the time of its organization in 1864 until his death in 1869; his father, Arthur D. Osborne, was a director from 1869 to 1916, was its President for seventeen years of that time, and Dr. Osborne himself succeeded his father as director December 28th, 1916. Both grandfather and father were lawyers.

[1] Printed with the permission of the president of the Second National Bank.

Dr. Osborne soon after his graduation from Yale engaged in research work in chemistry and devoted himself especially to study of the chemistry of nutrition and growth—biochemistry, in which he won great distinction. Yale gave him the honorary degree of Doctor of Science and appointed him research associate with rank of Professor, he served as member and officer of learned societies, was made honorary member of learned societies abroad, was awarded medals both here and abroad, and assisted in editorship of scientific journals—the story of his discoveries is known the world over. Pausing occasionally to publish his results, he has given his fellow-scientists new ground from which to work and contributed much to the physical well-being of all. Applause, however, he scarcely heard, for by the time it reached his ears he had eagerly resumed his quest for further truth. He was modest but realized the value of his own work—his modesty was that of the earnest man who regards success as a new foothold for further progress.

We, his associates on this Board, however, knew him in the broader relations of life. We respected him for his achievements in science, but we also came to realize and respect his knowledge and understanding of business, especially in its relation to government finance. He brought to the service of the bank a natural and inherited interest in its business, an understanding of its relation to the community and a lively interest also in public affairs and the larger problems of finance, which were considered by him with the relentless searching logic of the scientist, who must be sure of his premises. We have found him a real friend and have shared with him his sympathetic interest in the life of those around him. As directors we have been helped by his sound and kindly counsel. We gratefully acknowledge his service to this bank and the community.

Attest:

E. G. ALLYN,
Secretary.

THE YALE JOURNAL OF BIOLOGY AND MEDICINE[1]

The death of Thomas Burr Osborne on January 29, 1929, removes one of the most distinguished figures in American biochemistry. Descended from a long line of Yale men, himself a graduate of the class of 1881, his passing will be lamented by all who were associated with him, as well as by the many scientific investigators who have been influenced by his work.

Dr. Osborne's entire life was devoted to research in what was,

[1] Reprinted from 1, 187 (1929) by permission of the editor.

at the beginning of his labors, an almost unexplored field. The origin of his interest in chemistry may be traced to his friendship and association with Samuel W. Johnson, who was, for many years, Professor of Agricultural Chemistry in the Sheffield Scientific School and Director of the Connecticut Agricultural Experiment Station. After graduation, Osborne continued the study of chemistry and in 1885, received the degree of Ph.D., being the tenth man to obtain this degree in chemistry from Yale. His dissertation was entitled "The Quantitative Determination of Niobium," a subject certainly far enough removed from what later became his life work. This investigation had been preceded by studies on the analytical separation of zinc and was followed by a number of others also dealing with analytical problems. The foundation of his career was thus laid upon a thorough knowledge of analytical chemistry.

In 1886, Dr. Osborne was invited by Professor Johnson to join the staff of the Connecticut Agricultural Experiment Station, and he thus formed a connection which was maintained until his death. Professor Johnson had become interested in the work of Ritthausen upon the proteins of seeds, and, in 1888, he suggested that further study in this field might lead to useful results. The selection of the oat kernel as the first seed for investigation was probably influenced by some early work of J. P. Norton. That the choice was perhaps unfortunate is indicated by a statement made in Dr. Osborne's address on the acceptance of the Thomas Burr Osborne medal on June 7, 1928. "The first cereal with which I worked was the oat kernel, and I have long wished that someone would explain the unusual behavior of the proteins of this seed. In all my experience I have never found a seed containing proteins behaving toward solvents as these do." In spite of the extraordinary difficulties presented by the material chosen, he succeeded in isolating the proteins of the oat in a pure form, one of them, a globulin, in crystalline condition. This paper was followed by a series of investigations extending in almost unbroken sequence for ten years, in which preparations of the proteins from more than thirty different seeds were described. These descriptive studies were followed by several papers dealing with the nucleic acid of the wheat embryo and with the basic character of the protein molecule; papers which are among his most important contributions to science. In them he announced the discovery of a nucleic acid and showed that it contained the purines, guanine and adenine, in molecular proportions. He made it clear that preparations described in the literature as nucleoproteins were in reality salts of proteins with nucleic acid, and that the highly variable proportions of phosphorus in such preparations were to be accounted for by the fact that nucleic acid and proteins may unite with each other in variable proportions since proteins may behave as polyvalent bases, while nucleic acid is a polyvalent acid.

He next showed that edestin from hemp-seed could unite with hydrochloric acid in two different proportions forming definite and reproducible compounds, the compositions of which, with respect to the acid, were in the simplest possible stoichiometric relationship to each other. This was an accomplishment of the highest significance, since it indicated that proteins behave in accordance with the laws which govern the behavior of other and simpler basic substances.

This investigation initiated a second phase of Dr. Osborne's work in which the chemical properties and composition of proteins were primarily considered. Perhaps the best known of these studies is that which deals with the different forms of nitrogen in proteins (1908), in which it was shown that a definite part of the protein nitrogen is found, after hydrolysis, as ammonia, and that the amount of ammonia is so related to the proportions of glutaminic acid and aspartic acid derived from the proteins as to lend great weight to the view that these acids must occur as amides in the protein molecule. A further proportion of the nitrogen of proteins can be precipitated by phosphotungstic acid after hydrolysis and, therefore, probably belongs to basic substances. Dr. Osborne found that this proportion is very close to that to be expected from the sum of the amounts of arginine, histidine and lysine yielded by these proteins. He further demonstrated that the additional quantity of ammonia obtained when proteins were hydrolyzed by means of alkali, over that secured when acid hydrolyzing agents were used, could be closely accounted for by the secondary decomposition of arginine. This paper is one of the most widely quoted of Dr. Osborne's contributions to protein chemistry. In it he allowed himself almost the only prophecy to be found in his work. With respect to the proteins of the cereal grains he says, "they in some ways differ in structure from all the others which have been examined, and .... they may possibly contain some other dibasic acid not yet isolated from their decomposition products." This prophecy was fulfilled ten years later by Dakin's brilliant discovery of oxyglutaminic acid in several of the proteins to which Dr. Osborne had referred.

Beginning in 1906, and continuing for about six years, with the aid of a number of collaborators, Dr. Osborne carried out a series of analyses of the amino-acid composition of proteins. These analyses set a standard for such work, surpassed only since the introduction, in recent years, of greatly improved methods, and laid the foundations for the studies of the nutritive properties of proteins begun in collaboration with Prof. Lafayette B. Mendel in 1909, and continued until 1928. He had become greatly interested in the physiological properties of proteins, and a series of papers, in collaboration with Prof. H. G. Wells of Chicago, led to a clear understanding of the anaphylactogenic relationships of vegetable proteins.

The results of the work on nutrition problems are well known. A technique for the study of various diets, using rats as experimental animals, was perfected. Studies on the relation of amino-acid composition to the nutritive value of proteins showed that tryptophane and lysine were essential for growth and maintenance. The presence of an accessory food factor in butter-fat, subsequently designated as vitamin A, was discovered independently and this finding was published in 1913. In addition there were many studies on the nutritive value of isolated proteins and upon the mutual supplementation of various foodstuffs with respect to their protein composition. One of the most useful results of the experiments upon the vitamin requirements of animals was the recognition of the peculiar value of cod liver oil in nutrition, and an at least partial explanation of the high esteem in which this oil has long been held by the medical profession.

Osborne and Mendel have also contributed widely to the knowledge of the distribution of the vitamins in natural foodstuffs, and to the factors influencing the phenomena of growth, in particular to the study of dietary regimens resulting in the suppression of growth or in its acceleration.

One of the results of the study of vitamins was a clear conception, in Dr. Osborne's mind, of the importance of an investigation of the constituents of living cells. This led to a vast amount of labor upon the composition of green leaves, much of which did not reach the stage of publication. He enthusiastically coöperated in the labors of his assistants in this field and the work strikingly demonstrated the complexity of the chemical environment in which the life process takes place. Dr. Osborne's labors in the field of protein chemistry were summarized in his classical monograph "The Vegetable Proteins," first published in 1909, and extensively revised in 1924. His monograph on "The Proteins of the Wheat Kernel" (1907) is a standard text among cereal chemists. His published work includes nearly 250 journal reports as well as public addresses and more popular articles.

Dr. Osborne was one of the fortunate leaders of science in a highly technical field to whom recognition came in his own lifetime. He was awarded the honorary degree of Sc.D. by Yale in 1910, and in the same year was elected a member of the National Academy of Sciences. He was made an honorary fellow of the London Chemical Society in 1912, and a fellow of the American Academy of Arts and Sciences in 1914. He was an associate member of the Société Royale des Sciences Médicales et Naturelles de Bruxelles, a member of the American Philosophical Society, and of many other American and foreign learned societies. In 1923, he was made a Research Associate in Biochemistry of Yale University. In 1900, he was awarded a gold medal by the Paris Exposition, and in 1922, received the John Scott Medal. In 1928, he was the first recipient of the Thomas Burr Osborne Gold

Medal of the American Association of Cereal Chemists; a medal founded in recognition of his outstanding contributions to cereal chemistry.

Dr. Osborne was one of the most distinguished pupils of Prof. S. W. Johnson, and through him traced his intellectual ancestry back to Liebig, the founder of agricultural chemistry. The enormous increase in interest in the chemistry of proteins in this country, particularly in recent years, is to no small degree due to his direct influence. He was a painstaking, careful investigator who spared no effort, time, or expense in the attainment of the truth. He accepted no result until it had been subjected to the test of rigorous and repeated experiment, and all his publications bear the marks of meticulous editing lest a statement should to the slightest extent pass the bounds of ascertained fact.

To those who were privileged to be associated with him in his work he was a rare stimulus, a formidable opponent in argument, and an ever genial but just critic. He frequently closed a discussion with the remark that facts were to be found in the laboratory, not in books. He was naturally shy and retiring; the delivery of a public address or of a paper was a severe trial to which he looked forward with trepidation; but among a small group of friends he showed himself as a gifted conversationalist, who was equally able to discuss the latest achievements of science, the current political situation, the intricacies of the world of finance, or the faults of the modern educational system.

It has been said that the value and significance of a man's work is, in the long run, in no way influenced by what is said of it: ultimately it stands alone upon its intrinsic merit. The work of Thomas Burr Osborne is founded upon the basic principles of accuracy, honesty, and a desire to be of service to his fellow men. No more enduring monument to his memory can be erected than this.

HUBERT BRADFORD VICKERY.

EXPERIMENT STATION RECORD[1]

The career of Dr. Thomas Burr Osborne, ended by his death on January 29, 1929, personifies in an unusual degree the ideals of scientific research at the agricultural experiment stations. Entering the service of the Connecticut State Station in 1886, Dr. Osborne soon began a study of the vegetable proteins which became the major project of his life work and continued for almost 40 years. In this relatively intricate and difficult field he did a notable work and achieved wide recognition as an outstanding authority. As one who followed his studies closely from the

[1] Reprinted from 60, 701 (1929) by permission of the editor.

beginning has recently written, "he exemplified in the best sense the courage and perseverance of the investigator, coupled with the skill and creative ability so essential to discovery. His contribution was an unusually large one, and has been very far-reaching in its effects on our thinking and understanding."

Dr. Osborne's entire life was spent in the city of New Haven, where he was born on August 5, 1859. He was graduated from Yale University in 1881 and received the degree of doctor of philosophy from the same institution in 1885. His early interests were in the field of analytical chemistry, and for three years he was an assistant in that subject in Yale.

The enactment by the Connecticut Legislature of a law to protect the dairy industry and the general public from the increasing sale of unlabeled imitation butters made possible an increase in the chemical staff of the State Experiment Station in 1886, and it was in connection with this control work that he was given his original appointment. His service as a routine analyst, however, was brief and was supplemented almost immediately by studies of analytical methods. The report of the station for 1886 includes notes from his pen on the filtration of crude fiber and the filtration and weighing of silver chloride, and in the following year he gave much attention to devising methods of mechanical soil analysis.

The Connecticut State Station had been established with the immediate objective of providing a defense against fraud, but its aim, as stated in the act of incorporation, was "to promote agriculture by scientific investigation and experiment," and the station was not permitted to develop as either an exclusively control station or as one content with the simpler and more immediately useful forms of testing. Largely because of the broad vision and high ideals of those in whose charge its destinies had been intrusted, scrupulous care had been exercised so to organize its inspection service that it would not hamper the progress of research, to rest it at all times on the soundest basis which science could provide, and to develop as far as possible the more fundamental inquiries. Accordingly, in 1888, just as the Hatch Act was coming into operation, Director S. W. Johnson proposed an investigation of the vegetable proteins, and the station report for the following year tersely announced that "much time has been given by Dr. Osborne to a study of the nitrogenous matters contained in the kernels of maize and oats."

In this modest fashion began a series of investigations of outstanding importance. The studies were undertaken at a time when work in this field was known to be much needed, but the opportunity was being neglected. The first serious examination of the vegetable proteins had been instituted in 1860 by Ritthausen, who had demonstrated the occurrence of many diverse forms in the different seeds and indicated some of the difficulties and complexities of the subject. His work had been far from exhaustive,

however, and with the contributions of Denis and Weyl the matter had been left in much confusion. Because of its intricacy the subject was being regarded by chemists in general with some trepidation.

Dr. Osborne first directed his attention to a reinvestigation of the matters dealt with by Ritthausen. Utilizing and devising improved methods and working with characteristic thoroughness and care, he was soon able to show that the number of distinctive vegetable proteins is far greater than Ritthausen had supposed. Ultimately pure specimens of the proteins from no fewer than 32 different seeds were prepared, usually by several methods, and comprehensive descriptions formulated. Many of the proteins previously grouped together were found to be distinct substances. Specific designations were thereupon given them, and the use of older terms much restricted. As Vickery and Mendel, two of his former colleagues, have pointed out in a recent tribute in *Science,* "this clarification of the nomenclature has been of immense assistance in bringing a semblance of order into an almost hopelessly confused subject."

This phase of Dr. Osborne's activities continued for about 10 years and led logically to an investigation of the proteins as a group, their structure and their properties. Here again he was delving in a pioneer field, and again he was equal to the occasion. In the words of a resolution of appreciation adopted by the station board of control at his retirement from active service late in 1928, "his mind has always been raising questions, which he was able to define with rare precision, and then with equal discernment he has devised means for their experimental investigation and solution." By analysis and reanalysis he patiently and persistently advanced the boundaries of knowledge of the fundamental chemistry of the proteins and established a basis for the third and culminating stage of his research, a study of their nutritive values.

This study was begun in collaboration with Dr. L. B. Mendel in 1909, and involved among other requirements the development of a technique for feeding individual small animals diets containing the pure isolated proteins which he now had available. Unexpected difficulties arose in obtaining normal growth with young animals on what were supposedly adequate rations, but when these were overcome by the use of a "protein-free milk" prepared by removing the casein and lactalbumin from milk serum and evaporating, wide differences in the efficacy of the various proteins were revealed. For example, the animals grew well on wheat glutenin and edestin, but failed rapidly on zein and gelatin, while maintenance but not growth was possible on hordein and rye and wheat gliadin. Further work showed that by the addition of certain amino-acids the deficiencies could be rectified and growth made possible.

The great value and immediate practical bearing of these find-

ings were generally recognized, but even more important observations were to follow. These observations grew out of the use of the "protein-free milk" employed in the feeding experiments and indicated that there occurs in butter a substance essential for animal growth. Similar discoveries were reported at about the same time by McCollum and Davis, using an ether extract of egg yolk and of butter, and the essential substance was later designated vitamin A. Subsequently, Dr. Osborne and his associates noted the value of cod liver oil as a growth stimulant and particularly as the curative agent for the xerophthalmia regularly encountered in the animals receiving the deficient diets.

In 1911 Drs. Osborne and Mendel showed that the "protein-free milk" was much more efficient in inducing growth than was a corresponding mixture of lactose and pure salts or milk ash, thus implying the presence of some water-soluble organic growth-promoting substance. This early inference was later confirmed, and the studies contributed considerably to the development of our knowledge of the distribution of such a vitamin in foods and its significance in normal nutrition, particularly in connection with growth.

Many other extensive contributions were also made, as indicated in the following summary by Vickery and Mendel: "Much labor was devoted to the study of the nutritive value of the proteins of the commercially important foods, and this work gave a rational explanation of many practices which empirical experience had shown to be advantageous. The distribution of vitamins A and B in natural food products was studied, and considerable success was attained in an effort to prepare a vitamin-rich concentrate from yeast. The phenomena of growth, its suppression and acceleration under various regimens, the effect of the individual inorganic constituents of the diet, these and many other topics received attention at different times."

An idea of the extent of Dr. Osborne's labors may be gathered from the fact that a complete bibliography of his publications is said to reach 253 titles, of which about 200 are contributions to journals reporting his personal scientific work. This large number is the more remarkable in view of his conservatism in announcing his findings and his rigid insistence that no result must be made public that had not been verified by careful, thorough, and repeated experiment. Perhaps because of what has been termed his "meticulous editing," none of his published works are of great length, the most extensive probably being his monograph of 154 pages on The Vegetable Proteins, first issued in 1909 and extensively revised in 1924. This monograph and his report of 119 pages on The Proteins of the Wheat Kernel (1907) have long been regarded as classics in their respective fields.

The success of Dr. Osborne's work may fairly be considered a resultant of his personal efforts, characteristics, and qualifications,

and his favorable environment. To an unusual degree he represented the "exceptional investigator," of whom much is heard in discussions of research and research workers. He was well equipped by training and temperament to utilize to the full his advantages and to profit by his congenial surroundings. Assigned as a young man to a highly complex and difficult problem, he grew with his opportunity. Beginning in a small way, devising and adapting his tools for the task, he worked logically, patiently, and sanely. Progress was neither spasmodic nor spectacular, but it was steady and sure, with little lost motion and even less of following of blind trails and retracing of steps. Gradually the mosaic was assembled, and the work little understood or appreciated in its beginnings was impressively revealed.

Without detraction from the achievements of the central figure in the execution of this important project, it may be pointed out that much credit also accrues to his associates, his colleagues and coworkers, and especially to those who have formulated and executed the policies of the institution under whose auspices the work has been done. Outstanding among these have obviously been Director Johnson, at whose instigation and under whose enlightened leadership the investigation was originally conceived and gotten under way, and his successor, Director E. H. Jenkins, who without the incentive of project authorship assumed the responsibility for its continuance and suffered no interference with its progress. Nor should there be overlooked the consistent coöperation and support of successive boards of control, manifested through the years when results came slowly and their applications to practical farming seemed remote and improbable. If it is recalled that even after the passage of the Hatch Act the entire resources of the station did not exceed $20,000 per annum for several years, that the experiment station itself was on trial in Connecticut as elsewhere, with its usefulness as an aid to agriculture still to be fully accepted, and that a host of relatively simple problems of undoubted economic importance and popular appeal were pressing for solution, the courage and the vision of Dr. Osborne's supporters become manifest. When the contention is heard, as happens from time to time, that the agricultural experiment stations are too hard pressed for results of practical value and for immediate application to be looked to for systematic and long-time research along fundamental lines, the maintenance of Dr. Osborne's work year after year may well be included in the many instances which may be cited in rebuttal.

From various aspects, the story of Dr. Osborne intrigues the imagination and supplies a unique inspiration. Fortunately it is not only a story with a moral but a tale with a happy ending. Public recognition came slowly, and first of all, according to Vickery and Mendel, by way of Germany, when Griessmayer in 1897 published a treatise on the vegetable proteins that contained

many extracts from Dr. Osborne's papers and stated in his introduction that it was his hope "to bring to light these treasures buried in their American publications." By 1904, however, the fundamental character of the work had been so thoroughly established as to enlist substantial financial support from the Carnegie Institution of Washington, and this support has subsequently been continued without interruption as one of the comparatively few projects carried on at an experiment station which have ever received such aid. In 1908 the work was also accepted by the Office of Experiment Stations as an appropriate project under the recently enacted Adams Act, and this relationship likewise continued without material modification for nearly 20 years.

Personal recognition was ultimately accorded in generous measure. Yale University conferred the honorary degree of doctor of science in 1910, and in 1923 appointed Dr. Osborne a research associate in biochemistry with professorial rank. In 1920 he was elected a member of the National Academy of Sciences, in 1912 an honorary fellow of the Chemical Society of London, and in 1914 a fellow of the American Academy of Arts and Sciences, and he was long a member of numerous other societies at home and abroad. For many years he was associate editor of the *Journal of Biological Chemistry*. Three medals were awarded to him, the gold medal of the Paris Exposition in 1900, the John Scott medal in 1922, and (as the first recipient) the Thomas Burr Osborne gold medal established in his honor in 1926 by the American Association of Cereal Chemists in commemoration of his "notable services to cereal chemistry."

Late in 1928 and at his own request, he was relieved of active charge of the biochemical laboratory, at which time he was given the title of consulting biochemist by the board of control, with appropriate resolutions of appreciation. In the few weeks which followed, the memory of these honors and the many expressions of esteem of his colleagues and others doubtless brought him much pleasure, yet the guess may be hazarded that his highest satisfaction came from his own realization that he had achieved the goal of every true investigator, a lifetime profitably and productively spent in the elucidation of a worth-while problem. As Vickery and Mendel have well said, "his death removes one of the great pioneers of American biochemistry, a man whose name will always be linked with the subject he made peculiarly his own."

AMERICAN JOURNAL OF SCIENCE[1]

By the death of Thomas Burr Osborne on January 29, 1929, at the age of 69, modern biochemistry has lost one of its most fruitful investigators. Few students of science have devoted them-

[1] Reprinted from 17 (April, 1929) by permission of the editor.

selves more wholeheartedly, uninterruptedly and effectively to a few definite research objectives. Dr. Osborne served for a time on the teaching staff of the Chemical Laboratory at Yale. A number of his early contributions dealt with problems of analytical chemistry. In 1886 he became attached to the Connecticut Agricultural Experiment Station, then under the directorship of Prof. S. W. Johnson, and presently began a series of fundamental investigations on the occurrence and properties of proteins in plants, notably in the cereal seeds. These have been summarized in his monograph on *The Vegetable Proteins*, which has become the classic book of reference in its field. Subsequently in collaboration with a number of assistants he devoted himself to analytical studies of the structure of the proteins, whereby he was enabled to make fundamental contributions to our knowledge of the amino-acid makeup of the nitrogenous foodstuffs. The large experience and information thus secured served to awaken Dr. Osborne's interest in some of the biological properties of the proteins and bore fruition in outstanding investigations (in collaboration with Prof. H. G. Wells) on the anaphylactic properties of many plant proteins. Furthermore during a period of nearly 20 years he was engaged, in collaboration with Prof. Lafayette B. Mendel of Yale University, in elaborate investigations of the comparative nutritive value of proteins. Observations made in the course of these studies further led to various discoveries regarding those nutritive properties of foods now designated as vitamins. The physiology of growth likewise became a subject for extensive consideration. Dr. Osborne's various contributions presented in more than 250 scientific papers brought recognition and distinction to him from many sources. Few chemists have been privileged to follow the dictates of their interest so long and successfully without the interruptions or distractions that may retard the progress of the devotees of science.

L. B. M.

JOURNAL OF THE CHEMICAL SOCIETY[1]

Thomas Burr Osborne was elected an honorary Fellow of the Chemical Society in 1912 and his death on January 29th, 1929, removes one of the most distinguished figures in American biochemistry. The Chemical Society has seldom honoured with its honorary Fellowship investigators whose work has been concerned chiefly with the biological side of chemistry, thus Osborne's election was an exceptional tribute to the scientific worth of his labours.

Osborne's scientific life was entirely centered around New

[1] Reprinted from page 2974 (1929) by permission of the editor.

Haven. A student of Yale University, he received the degree of Ph.D. for a thesis on "The Quantitative Determination of Niobium." In the year following graduation he was invited by Professor S. W. Johnson to join the staff of the Connecticut Agricultural Experiment Station, thus forming a connexion which he maintained throughout life. Up to this time Osborne's work had been entirely concerned with analytical chemistry, and the cause of his deflection to biological chemistry may not improbably be referred as much to the heart as to the head. His devotion to Johnson, himself a pupil of Liebig and for long one of the outstanding leaders in agricultural science, and his subsequent marriage to Professor Johnson's daughter combined to make the transition an easy one.

In broad outline Osborne's contributions to biochemistry may be considered in three main groups. First, the preparation of many proteins, especially those found in vegetable seeds, in a state of relative purity quite unattained by previous investigators. Many of these proteins were obtained in crystalline form and characterized in a thoroughly convincing fashion. Having the command of relatively pure proteins in large amounts, Osborne devoted the second phase of his work to the analysis and identification of their products of hydrolysis: the results are of permanent value and are constantly utilized by others, but it may be conceded that the methods made use of were chiefly worked out by Kossel, Fischer, and others and that Osborne's own contributions to methods of protein analysis seem modest in comparison with his other outstanding accomplishments. The third and certainly the most striking part of Osborne's work dealt with the biological properties of his highly purified proteins; first of all in relation to their specific antigenic properties and their ability to produce that extraordinary phenomenon known as the anaphylactic reaction—and subsequently their rôle in animal nutrition. The latter phase of Osborne's work brought into prominence the importance, from the standpoint of nutrition, of minute amounts of substances associated in varying degree with certain foodstuffs which are now grouped under the name of "vitamins." In particular he contributed largely to the discovery of the substance present in butter fat which was later distinguished as vitamin A and is essential for animal existence.

In the following year the important observation was made that the same stimulation of growth could be secured by the addition of cod liver oil to a diet of purified food substances and protein-free milk, a discovery which served to focus attention upon the value of this oil, in particular as a curative agent for the peculiar eye condition known as xerophthalmia, which was regularly encountered in animals on the deficient diets. At the close of the war the sight of many children in Europe was preserved by

its use, a remarkable example of the application of scientific results to practical problems.

One of the results of the study of vitamins was a clear conception in Osborne's mind of the importance of an investigation of the constituents of living cells. This led to a vast amount of labour upon the composition of green leaves, much of which did not reach the stage of publication. He enthusiastically coöperated in the labours of his assistants in this field and the work strikingly demonstrated the complexity of the chemical environment in which the life process takes place. Osborne's investigations in the field of protein chemistry were summarized in his well-known monograph "The Vegetable Proteins," first published in 1909, and extensively revised in 1924. His monograph on "The Proteins of the Wheat Kernel" (1907) is a standard work of reference among chemists who are occupied with the problems of cereal foods. His published work includes nearly 250 journal reports as well as public addresses and more popular articles. Shortly before his death Osborne published jointly with his colleague and successor, H. B. Vickery, a monograph in *Physiological Reviews* entitled "A Review of Hypotheses of the Structure of Proteins," which must be regarded not only as a confession of faith but as one of the sanest and most wisely critical essays on a most difficult subject. His last paper on "The Chemistry of the Cell" concludes with the following sentence, which is so typical of Osborne's scientific caution and dislike for premature speculations that it may be quoted: "I fear that for a long time to come much will still remain to be learned about the chemistry of the cell, but if, in the meantime, we can extend our knowledge of this subject it may save us from many erroneous conclusions based on incorrect results obtained without sufficient appreciation of the real nature and complexity of the problem."

Osborne was singularly fortunate in his conditions of work and enjoyed happy associations with many colleagues of distinction, notably Gideon Wells, Mendel, Vickery, and Wakeman. His extensive investigations would have been impossible without generous financial support and encouragement. Throughout the early years, when results came slowly and their application was by no means apparent, the directors of the Connecticut Agricultural Experiment Station allowed no interference or distraction to hinder the progress of the work. Since 1904 a large proportion of financial burden has been borne by the Carnegie Institution of Washington, D. C., of which he was a research associate. Osborne's connexions with hoth the experiment station and the Carnegie Institution of Washington furnish a striking example of the value to science of a policy of non-interference on the part of those in control of the distribution of funds for research. Except for routine annual reports, he was never asked for state-

ments of progress or for outlines of projects. The relationship was always one of the utmost mutual confidence and esteem.

To those who were privileged to be associated with Osborne in his work he was a rare stimulus, a formidable opponent in argument, and an ever-genial but just critic. He frequently closed a discussion with the remark that facts were to be found in the laboratory, not in books. He was naturally shy and retiring, but among a small group of friends he showed himself as a gifted conversationalist, who was equally able to discuss the latest achievements of science, the current political situation, the intricacies of the world of finance, or the faults of the modern educational system. Few men have been more free from what Bacon has termed "the first distemper of learning, the studying of words and not matter."

H. D. D.[1]

THE YALE ALUMNI WEEKLY[2]

Thomas Burr Osborne died at his home in New Haven on January 29. He had suffered an acute attack of heart disease a few days before. Osborne received his preparation for college at the Hopkins Grammar School. At Yale he was given a first colloquy appointment in both junior and senior years, served as president of the Yale Natural History Society for three years, and belonged to Psi Upsilon and Skull and Bones. He specialized in chemistry in the Yale Graduate School from 1882 to 1885, when he received the degree of Ph.D., and was an assistant in analytical chemistry from 1883 to 1886. Osborne was connected with the Connecticut Agricultural Experiment Station in New Haven as chief in protein research from 1886 until his retirement from active direction of the work of the laboratory last summer and had since held the position of advisory biochemist. He was a research associate of the Carnegie Institution in Washington, and he had been connected with the Yale faculty as a research associate in biochemistry, with the rank of professor, since 1923. Osborne had won preëminent recognition as an authority in the field of vegetable proteins and had served as president of the American Society of Biological Chemists and as an associate editor of the *Journal of Biological Chemistry*. He was the author of ***Proteins of the Wheat Kernel*** and ***The Vegetable Proteins*** and had contributed numerous papers to various scientific journals. Yale conferred the honorary degree of Sc.D. upon him in 1910, and he was elected to membership in Sigma Xi in March, 1928. He was awarded the Paris Gold Medal in 1900 and the John Scott

[1] The writer gratefully acknowledges his indebtedness to Dr. Vickery's article on Dr. Osborne's work published in the *Yale Journal of Biology and Medicine*, March ,1929.

[2] Reprinted from page 576 (Feb. 8, 1929) by permission of the editor.

Medal in 1922, and in 1928 he was the first recipient of the Thomas Burr Osborne Gold Medal, which was established in his honor by the American Association of Cereal Chemists in 1926. Osborne was an honorary member of the London Chemical Society, an associate member of the Société Royale des Sciences Médicales et Naturelles de Bruxelles, and a fellow of the American Academy of Arts and Sciences. He was married in 1886 to Elizabeth Annah Johnson, of New Haven, who survives him with one of their two sons, Arthur D. Osborne, '08. The younger son died in childhood. Osborne was the son of Arthur D. Osborne, '48, a brother of Arthur S. Osborne, '82, a grandson of Eli W. Blake (B.A. 1816) and Thomas B. Osborne (B.A 1817), a great-grandson of Ebenezer Dimon (B.A. 1783), and a great-great-grandson of Ebenezer Dimon (B.A. 1728). Other Yale relatives are: Eli Whitney (B.A. 1792), David Dimon, a non-graduate member of the Class of 1828, Theodore Dimon (B.A. 1835), E. Whitney Blake (B.A. 1839), Charles T. Blake, '47, Henry T. Blake, '48, William P. Blake, '52 S., George A. Blake, ex-'54, Eli W. Blake, '57, Edward F. Blake, '58, John M. Blake, '58 S., James P. Blake, '62, Frank W. Blake, '72, George A. Bushnell, '76, Francis H. Blake, '82 S., Edward Blake, '84 S., Joseph A. Blake, '85, Henry W. Blake, '86 S., Donald M. Barstow, '89, T. Whitney Blake, '90 S., James K. Blake, '91, Robbins B. Anderson and Howard C. Robbins, both '99, and H. Kingsley Blake and Joseph A. Blake, Jr., both '16.

NATURE[1]

Thomas Burr Osborne, who died on January 29, was the last of the small band of pioneers who laid the foundation-stones of modern protein chemistry. Born in New Haven, Connecticut, on August 5, 1859, of old New England stock, he graduated after the usual course in arts at Yale College in 1881. Turning his attention to analytical chemistry, he took the degree of Ph.D. in 1885, and a year later joined the staff of the Connecticut Agricultural Experiment Station in New Haven. Professor S. W. Johnson, director of the station and professor of agricultural chemistry at Yale, suggested that Osborne should extend Ritthausen's early work on vegetable proteins, and in 1888 he started investigations which continued without interruption until his retirement in 1928.

From 1890 until 1901 Osborne's chief interest was in the preparation of pure specimens of the seed proteins, and his initial investigation of the oat kernel, published in 1891, was the forerunner of a series of papers in which the proteins of thirty-two different

[1] Reprinted *from* **123,** *613 (1929) by permission of the editor.*

seeds were described. These researches demonstrated that proteins could be regarded as definite chemical individuals, and that many substances formerly grouped together under such terms as "legumin," "conglutin," and "vitellin" differed in chemical composition as well as in physical properties. His conception of the protein molecule as a definite chemical entity was strengthened by his work on the acid-binding power of edestin, published in 1899, and by later papers in which it was shown that proteins in general could form salts with both acids and bases, and that they were capable of electrolytic dissociation.

Working as he did in close contact with agriculture, Osborne early realized the need of a chemical characterization of proteins which would give some index of nutritive value, but characteristically deferred any such research until he was convinced that he could first obtain proteins in the highest state of purity. Taking full advantage of the developments in analysis due to Kossel and Fischer, he commenced in 1906 a series of protein analyses which demonstrated that wide differences existed in the amino-acid composition of many proteins of economic importance. These analyses were made with Osborne's usual extreme care and were the basis of his future work on the nutritive value of the proteins, begun in collaboration with Professor Lafayette B. Mendel of Yale, in 1909, and continued with the generous support of the Carnegie Institution of Washington until the time of his death.

The results of Osborne's protein investigations were summarized in a monograph, "The Vegetable Proteins," which was published in 1909, and extensively revised in 1924. His life was devoted almost entirely to his research, and, unlike most investigations, increasing years and fame brought no increase in administrative responsibility, consequently until the last his working hours were spent in the laboratory, and those who were privileged to work with him and gain his confidence found in him not only a genial friend and stimulating critic, but also a man with an unsurpassed wealth of practical experience in his own particular field of science.

Osborne was a member of the National Academy of Sciences, an honorary Sc.D. of Yale, and an honorary fellow of the London Chemical Society. Last year the American Association of Cereal Chemists instituted the periodic award of the Thomas Burr Osborne medal for distinguished research in cereal chemistry, and he was himself the first recipient.

A. C. C.

Obituary notices were also published in the *Bulletin de la société scientifique d'hygiène alimentaire,* 17, 401-404 (1929) and the *Ware-ra no Kwa-gaku,* a scientific journal edited by Prof. R. Nakaseko of the Imperial University of Kyoto, 2, 283-284 (1929).

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[1] The greater part of this paper was translated and reprinted by V. Griessmayer in "Die Proteide der Getreidearten, Hülsenfrüchte und Ölsamen sowie einiger Steinfrüchte," Heidelberg, 1897.

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Also *J. Am. Chem. Soc.*, **19**, 482-487 (1897).
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Z. landw. Versuchsw., **2**, 65-70 (1899).

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Also *J. Am. Chem. Soc.*, **19**, 487-494 (1897).
Translation: Die Proteide des Sonnenblumensamens.
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Also *J. Am. Chem. Soc.*, **19**, 494-500 (1897).
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Also *J. Am. Chem. Soc.*, **19**, 509-513 (1897).
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Also *J. Am. Chem. Soc.*, **19**, 525-532 (1897).
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Translation: Die Proteide der Linse.
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Also *J. Am. Chem. Soc.*, **20**, 393-405 (1898).
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Also *J. Am. Chem. Soc.*, **20**, 406-410 (1898).
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Z. anal Chem., **43**, 299-301 (1904).

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Z. anal. Chem., **43**, 378-382 (1904).

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Am. Med., **9**, 1028 (1905).

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Z. anal. Chem., **48**, 98-108 (1909).

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Translation: Die Verbrennungswärme der vegetabilischen Proteine.
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Z. anal. Chem., **49**, 270-283 (1910).

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Translation: Hydrolyse des Exzelsins.
Z. anal. Chem., **48**, 616-622 (1909).

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Translation: Hydrolyse des Hordeins.
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Translation: Die Proteine der Erbse.
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Translation: Hydrolyse des Erbsenlegumins.
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Bulletin 313 March, 1930

THE ORIENTAL PEACH MOTH IN CONNECTICUT

PHILIP GARMAN

Connecticut
Agricultural Experiment Station
New Haven

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THE TUTTLE, MOREHOUSE & TAYLOR COMPANY, NEW HAVEN, CONN.

SUMMARY

1. *Damage from the Oriental peach moth* in Connecticut peach orchards annually amounts to more than $100,000.

2. *Its chief means of spread* lie in shipments of infested fruit; less important means in nursery stock movements and local flights of moths. Quinces and peaches are most seriously infested and few peach moth larvae have been found in other Connecticut fruits.

3. *The mature peach moth larva* is pink. Young ones are black-headed. Curculio larvae are curved and have yellow heads. Codling moth larvae and lesser apple worm larvae are more difficult to distinguish. (Page 407.)

4. *The peach moth's habits* are baffling and its defense almost perfect. Continuous generations in midsummer, the larval habit of digging in without eating materials placed on the surface and the ease with which peach trees are burned by insecticides, preclude use of extended spray schedules. (Page 409.)

5. *The life cycle* in peaches requires 32 days in midsummer and is divided among the various stages. Moths appear in early May and continue to emerge until mid-June. Three and sometimes a partial fourth generation of larvae occur, the first infesting twigs, the second twigs and fruit, and the third fruit.

6. *Field experiments* with bait pans, lime, and talc have given little or no control of the larvae in fruit. (Page 428.) Nicotine sulfate and white oil emulsions have afforded more control, but not enough to warrant recommending them. (Page 428.) The cost of the last two is also prohibitive. Cultivation seemed to give good results when it was first used at Wallingford, but it was not effective at Southington. (Page 435.) Paradichlorobenzene, heretofore recommended for wintering peach moth larvae, is usually applied before the majority spin. (Page 435.)

7. *A number of laboratory* control experiments have been conducted. (Page 413.)

8. *Attempts at colonization of the parasites Trichogramma minuta* and *Macrocentrus ancylivora* were made in 1929. (Pages 440 and 443.)

9. *At the request of orchard owners* artificial propagation of parasites has been started, using funds contributed in part by the growers themselves.

CONTENTS

PAGE

History in the United States 401
- Origin 401
- Methods of spread 402
- Injury 403

Appearance of the moth 404
- Differences between peach moth larvae and other larvae 406

Habits 406
- Adult 406
- Larva 408
- Cocoon and pupa 409

Seasonal life history 410

Length of life periods 412
- Egg 412
- Larva 412
- Cocoon and pupa 413
- Adult moth 413

Laboratory experiments 413
- Control of the eggs 413
- Control of the larvae 423
- Control of the moth 427

Field controls 428
- History 428
- Control experiments in Connecticut 429
- Control in twigs 432
- Cultivation 435

Summary of controls 435

Recommendations 436

Parasites 436
- *Macrocentrus ancylivora* Rohwer 438
- *Glypta rufiscutellaris* Cresson 441
- *Trichogramma minuta* 441
- Modifications of orchard practices to favor parasites 444
- Attempt to rear parasites under artificial conditions 444

Acknowledgments 444

References to literature 445

THE ORIENTAL PEACH MOTH IN CONNECTICUT

PHILIP GARMAN

The Oriental peach moth[1] is probably the worst enemy with which peach growers in Connecticut have to deal today. Because of the great difficulty of controlling it by any known sprays or other practices, it has attracted more and more attention on the part of growers, while the monetary loss has continued to mount into thousands of dollars annually. The insect was found in Connecticut about 1917, but it was not until 1924 that growers felt commercial damage. Between 1924 and 1929 it gained in destructiveness, infesting more and more orchards, in many of which it has been difficult to obtain sound fruit.

Considering the insect to have been in Connecticut since 1917 and our present infestation to be now at its height, it will be seen to have required 10 to 12 years to reach destructive numbers. Reports from available sources during 1925-1929 showed distinct advances in Connecticut on the part of the peach moth, although it was slow in establishing itself in many orchards and in a few seemed to decrease. Figures 26 to 28.

Much of the information contained herein has already been published, but the demand for literature about the insect has increased so much that it seems desirable to assemble it in one publication.

HISTORY IN THE UNITED STATES

Briefly, the history of the peach moth in the United States is as follows: The United States Department of Agriculture discovered it about 1916 near Washington, where it became destructive in the years 1917 to 1919. From this point it has seemed to spread almost in the form of a circle increasing in diameter from year to year, until at present practically all peach-growing states east of the Mississippi and portions of Canada are infested. The damage probably runs into millions of dollars every year.

Origin

The true origin of the peach moth is probably not known. It came to this country from Japan in flowering cherries, but Japanese authorities maintain that it was not there before 1899. It is

[1] *Grapholitha (Laspeyresia) molesta* (Busck); *Cydia molesta* (Busck) in British literature; order Lepidoptera, family Tortricidæ. Known also as the Oriental fruit moth, Oriental peach worm and Oriental fruit worm; in Japan as the smaller pear borer. It has been called the peach tip moth in Australia.

present now in Australia, Japan, China (Manchuria), Korea, Italy, France, Canada, United States, and probably in other countries. It has been reported as doing considerable damage in most of the regions where it is found, but appears to be less important in Australia and Italy than in others.

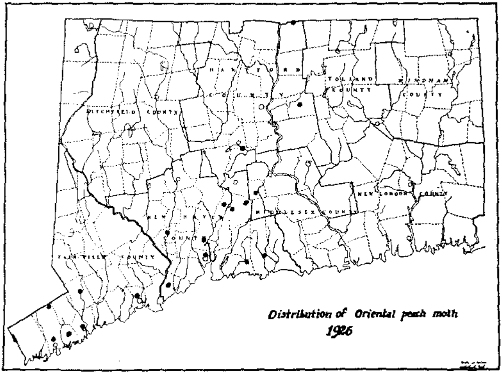

FIGURE 26. Map of Connecticut showing recorded distribution of the Oriental peach moth in 1926.

Methods of Spread

The Oriental peach moth flies readily in the adult stage and can therefore travel from orchard to orchard in any given locality. It is known to infest nursery stock and some are doubtless carried on young trees, since the over-wintering cocoons on the trunks or branches are very difficult to detect. The most important means of spread, however, lie in the shipment of wormy fruit, which sometimes comes into Connecticut in considerable quantities, and in the local distribution of fruit from town to town or district to district, which results in a steady increase of the general infestation. Containers of various kinds, such as barrels, peach baskets or bushels, in which fruit has been stored and in which the larvae frequently spin for hibernation are also important sources of danger and spread.

Injury

The amount of injury in different orchards varies considerably. As a rule, in orchards carrying 10 per cent or less of wormy fruit, the damage is not noticed, but when it averages much higher, it causes trouble in sorting, increase in brown rot and reduced sale value. Such fruit requires careful sorting because of the disagreeable gummy appearance, while much that remains, even after the greatest care has been taken, may contain larvae which have entered without leaving a trace. If there is much worminess

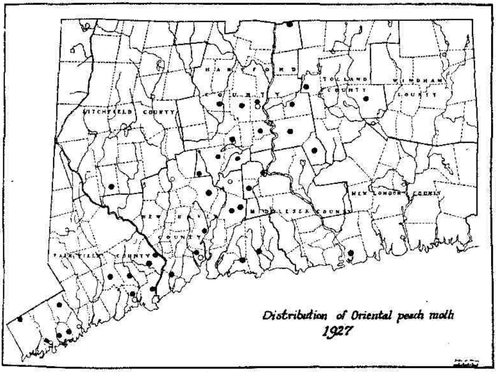

FIGURE 27. Map of Connecticut showing recorded distribution of the Oriental peach moth in 1927.

invisible from the outside, the peach finds its way into the hands of the consumer, sometimes with undesirable results. Dropped fruits resulting from an infestation are shown on Plate XI, b.

We have seen orchards in the central part of the State carry 50 to 100 per cent of infested fruit, and in some instances, the fruit may contain more than a single larva per peach. In quinces, the infestation is often more severe than in peaches, so that where the quinces are heavily infested, each fruit may contain several larvae. We have counted as many as five larvae in a single quince and under some conditions even more than this may be found. The damage to apple and pear fruits has been slight so far in Con-

necticut. Reports of injury to apples amounting to 50 per cent of the crop is reported from states to the south, but no cases of this sort have come to our attention. Most injury reported as peach moth injury, thus far investigated, has proved to be codling moth or lesser apple worm and not the Oriental peach moth.

The peach moth infests occasionally other fruits, such as cherry, Japanese quince, apricots and nectarines, but it has not yet been seen to do extensive damage to these plants in Connecticut. Pears are said to be heavily infested in Japan.

The amount of damage to peaches was estimated by Mr. Harold M. Rogers, president of the Connecticut Pomological Society, to be $150,000 or more in 1928. In 1929, the loss was considerably greater and the estimates probably averaged $200,000. This year the quince crop was almost a total failure, and although not large, would raise the total considerably. Figures of this sort are estimates only, but they do show that tremendous damage is being done annually to the peach business within the borders of the State, a loss which is most discouraging because of the fact that the injury cannot be prevented.

APPEARANCE OF THE PEACH MOTH

Egg. The egg appears as a small flat scale adhering closely to the leaf or fruit, usually white, often semi-transparent, and sometimes faintly reticulated. It is about the size of a pin-head, measuring .5-.7 mm. across. Plate VIa, c.

Larva. The young newly-hatched larva is about 1.4 mm. long, the head capsule measuring .22 mm. or about .1 of an inch. It is a small white larva with a black head. The second instar is similar in appearance, being slightly larger, the head capsule measuring about .36 mm. across. The head capsule of the third instar is .64 mm.; that of the fourth instar about .81 mm. The fifth or last instar measures 12 mm. or about .5 inch in length, while the head capsule measures on an average 1.0 mm. In this instar, the head turns brownish in color, and the body becomes pinkish. The over-wintering larva tends to become shorter and thicker than mature summer larvae. Plate V, a; VII, b.

Pupa. The pupa is brownish in color, turning nearly black just before the adult emerges. It is 6-7 mm. in length.

Moth. The adults (Plate VI, a, b) are small grayish-brown moths, with wings silvery on the under surface and figured with light wavy lines above. They are inconspicuous when the wings are folded. The male and female are similar, but the male abdomen is more slender than the female's. The appendages of the two sexes are shown in Figure 32, A and B; wing spread 12.5 mm. (.5 inch); body length 4-5 mm. (about .2 inch). Wing venation of the female is shown in Figure 31.

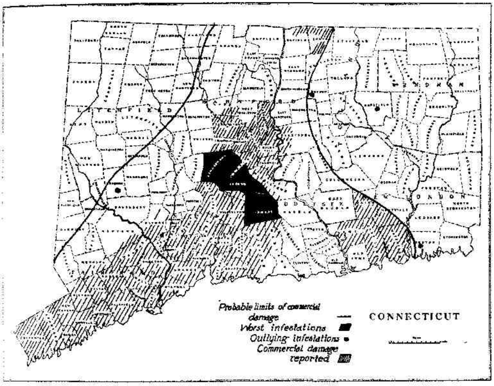

FIGURE 28. Map of Connecticut showing distribution of the Oriental peach moth in 1928. In 1929 the black area spread over Hartford County and northeast to and beyond the line of commercial damage in 1928.

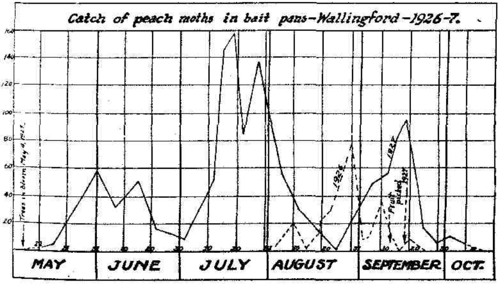

FIGURE 29. Periods of adult Oriental peach moth activity in 1926 and 1927. This shows the relative abundance at different periods during the summer, in an Elberta orchard. It also shows that the peak of the third generation varies from year to year in the same orchard.

Differences between the Peach Moth Larvae and Other Similar Larvae

Plum curculio. It becomes important on occasion to distinguish between the Oriental peach moth larva and larvae of insects such as the plum curculio, codling moth, lesser apple worm, quince curculio and others. In peaches certain conditions tell whether the peach moth or some other pest is present. For example, the curculio larva, one of the most commonly encountered, is most abundant in June and July and is rarely present when the fruit is ripening—at least in Connecticut. The peach moth, furthermore, becomes pinkish when full grown; the curculio larva never does, being more often a white or yellowish tint. The peach moth frequently makes more of a gummy mess at the surface, filling it with excrement, except for the late entries where no trace can be found. If the twigs of young peach trees or new rank growth of old trees are examined, many of the twigs will be found to be tunnelled, whereas, this is not the case when curculios alone are abundant. Finally, the head of the peach moth is black when small; the curculio head is yellow. The appearance of the peach moth and curculio may be visualized by a comparison of figures on Plate V, a.

Apple worms. There is greater difficulty distinguishing the Oriental peach moth larva from that of the lesser apple worm, especially in the younger stages, since both have nearly the same microscopical characters and general appearance. When older, the larva of the lesser apple worm takes on a decided orange hue, whereas the peach moth larva remains a delicate pink. For those not specialists in the group, this is probably the most satisfactory means of distinguishing them. Another species commonly found in apples, the codling moth, may be distinguished from the peach moth by its size. The codling moth is usually larger, is more prominently spotted, and lacks the anal comb possessed by the peach moth. Figure 30.

Quince curculio. In quinces, the quince curculio is most commonly confused, but this species resembles the plum curculio in general characters, being a curved larva with a yellow head, and whitish or yellowish in appearance.

HABITS

Adult

Adults emerge during the day, usually resting awhile before becoming active. They fly most actively towards sundown, but have also been observed (25) in the middle of the day. Eggs are laid for an hour or two before and after sundown and some in

early morning. Mating takes place usually within two days after emergence from the cocoon and egg laying commences shortly afterwards. The moth requires some water and food (sugars) since it is attracted to fermenting baits and seeks such food in cages. In general, the flight is very irregular, most of the moths apparently remaining near the tops of the trees when in flight,

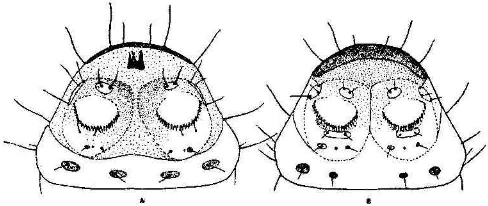

FIGURE 30. Anal segments of larva of (A) Oriental peach moth and (B) the codling moth, showing difference in structure.

and progressively fewer being found on approaching the ground. As already mentioned, they are attracted to baits and to some

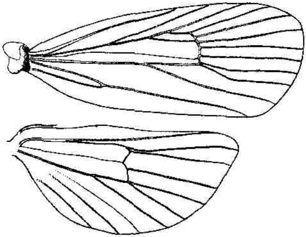

FIGURE 31. Wings of the Oriental peach moth with scales removed, showing veins.

extent to lights. Peterson has shown that ultraviolet rays are most effective (46).

In captivity, warmth and humidity are required before many eggs are deposited and crowded conditions are conducive to high egg yields. Moths lay best, in our experience, when kept in a

warm tent with added heat about sundown, particularly if the weather is cool. If not cool, no additional heat is necessary. If very hot, 90-100°, the moths suffer and many die without laying. Humidity above the average is desirable. A cage used for confining the moths is shown on Plate XI, a.

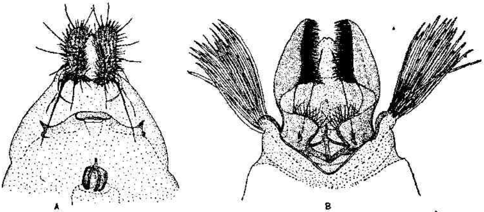

Figure 32. Tip of the abdomen of (A) the female and (B) the male peach moths, showing details of structure.

Eggs are laid on peach leaves usually on the under side, sometimes on the upper side and on the stems, but never on the fruit itself. On quinces, they may be deposited on upper or under surfaces of the leaves, on the sepals of the fruit, or on the fruit itself. The eggs are said to be placed directly on the fruit of pears, in Japan. On peach trees, they are often deposited on leaves at some distance from the fruit or twig that the larva infests. In cages, they will lay eggs on almost any material of the desired smoothness. Many eggs have been obtained on wax paper when the moths are confined in cages (71), a scheme which makes it possible to rear the insect continuously during the winter when no peach leaves are available for oviposition. They will lay on glass, tin, or even smooth wood surfaces when compelled to do so by absence of surfaces natural to them.

Moths are rarely observed in the orchard except towards sundown. Even then, many other species are likely to be confused unless captured and examined closely. Probably the best way to determine the presence of the peach moth lies in the use of bait pans, which are discussed on page 428. The moths are easily recognized in such pans, especially during midsummer, when many may be seen floating on the surface of the bait.

Larva

On hatching, the minute larva slips out from the side of the egg, and being very active, soon finds a suitable twig or fruit

where it starts immediately to work. It usually enters peach twigs near, but a little below, the actively growing tip sometimes through the base of the leaf. Plate I, a, b, shows typical twig injury. Peaches are entered near the stem, or through the stem itself (Plate II, a), leaving little or no trace at the point of entry. Sometimes the fruit is entered through the side, especially if two fruits or a fruit and a leaf are in contact. Plate II, b; III, a. Quinces are usually entered through the calyx end, though occasionally at other points. Plate IV. It is well known that the larva, on burrowing into the fruit or twig, throws aside the first mouthfuls until well below the surface. This is also true of the larvae that transfer from twig to twig when partly grown, or from twig to fruit. The hahit makes the insect very difficult to kill because of the fact that whatever poisons may be present on the outside of the fruit or twig are automatically discarded.

In peach twigs, the larva continues to feed on the central core until mature, unless forced out by an accumulation of gum, when it seeks another twig or fruit to continue its development. Two to three twigs may be tunnelled by a single larva.

In peaches the larva, for the most part, continues to eat next to the pit (Plate III, b), excavating a hole of considerable size and filling it with excrement. When fully grown, it bores through the side of the fruit and seeks quarters for cocooning. Only one fruit is usually infested by a larva.

The behavior in quinces is essentially the same as for peaches, except that the larva seems to wander about more in the flesh, making tortuous tunnels throughout.

In apples, the tunnels are similar to those in quinces. They differ from the usual work of the codling moth, which burrows directly to the core if it enters through the calyx or if through the side, after making a shallow mine under the skin. Young larvae have great difficulty entering through the skin of the apple, which probably accounts for their present scarcity in this fruit in Connecticut. They are, however, reared very easily in this fruit when points of entrance are provided and either ripe or green apples may be used.

Cocoon and Pupa

After leaving the fruit the larvae spin or crawl down seeking quarters to transform either on the ground or on the trunk of the tree. A small percentage spins on the branches of the tree itself. They will seek hollow stems and will spin on the soil itself, boards, or even dried peach mummies lying on the ground. On the trunk, they most frequently crawl under a flap of bark, sometimes abandoning a cocoon after construction, evidently because of an unsuitable location. The cocoon itself is con-

structed of fine silk, and is covered with bits of bark or other material taken from the material on which the cocoon is constructed. If the soil is well cultivated at the time of spinning, many are naturally forced to the trunk and spin within a few feet of the ground. During the winter, a majority of the larvae on the trunks will be found on the north side, but there are many that also spin in other locations. The general tendency, however, seems to be to spin away from the sun.

The cause of hibernation may naturally be attributed to cold, either its effect upon eggs, larvae or adults. However, in 1929 there was considerable hibernation (34 per cent) of larvae obtained from eggs placed July 19 immediately after oviposition in an incubator kept constantly at 70° F. From this, it would seem that whatever conditions affected hibernation were *present when the eggs were laid,* and they may be enzymatic in nature as suggested by Shelford,[1] rather than due to effects of temperature.

SEASONAL LIFE HISTORY

Moths emerge from hibernation in Connecticut during the middle or fore part of May and continue to emerge for probably a month under normal conditions. There is a considerable difference in the time of emergence, depending on the location of the cocoon, that is, whether protected from the sun or not. Under normal conditions shade is provided by the foliage shortly after warm weather begins, so that delayed emergence takes place. Bait pan records indicate that moths are most abundant about the first of June, and this corresponds in general with our insectary records. When placed in warm tents such as were provided in 1929, or exposed to direct sunlight, appearance of the moths is much earlier, but in Connecticut we have seen no evidence of advance emergence in the field. In packing houses or cold storage plants, however, emergence is much later and where these are near bearing orchards it will doubtless effect the sequence of the broods appearing in the orchards nearby.

The various flight periods of the adult are essentially as shown in Figure 29, but it has been observed in two years in two different orchards that the greatest number of moths were caught in bait pans during the middle of July or at the height of the second brood. In 1929 the number exceeded 1,000 a week in 20 bait pans during this period, whereas it dropped considerably below that figure in both June and August. In 1926, however, there were more moths caught in June than in July or August, although during that year all three broods were about equal. The reason for these conditions can only be surmised but may be connected in some way with the hibernation of certain individuals or in parasitic action.

[1] Laboratory and Field Ecology, 169. 1929.

The eggs of the first brood are laid beginning in May and continuing until the latter part of June and those of the second and third generations from July to late September.

Larvae are found in the fruit or twigs following the course of egg-laying activity, as shown in Figure 33. Larvae of the second generation may enter peaches in small numbers, but the number

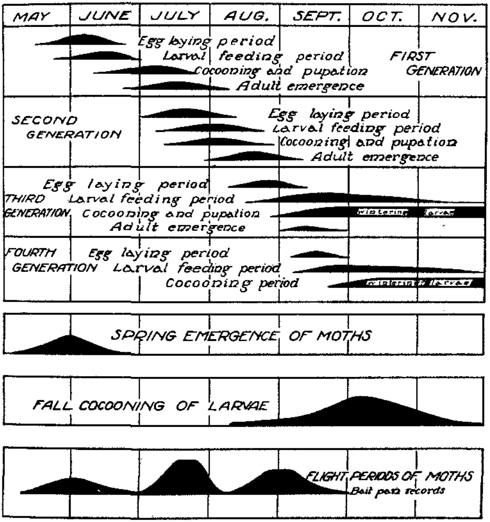

FIGURE 33. Life history chart of the Oriental peach moth.

increases rapidly with the appearance of the third brood and the ripening of the fruit. Hibernation tendencies begin to be apparent shortly after the first of August.

Emergence from fruit takes place during August, September and October and may continue until December. In 1928 the majority of larvae left the quinces and peaches in October and some the first part of November, while few or none emerged from the fruit after this date. In 1929 the emergence from fruit was

apparently much earlier and although it again continued during October, it probably reached its peak in September of this year. The year 1928 was a wet one; 1929 very dry.

Spinning takes place, of course, shortly after leaving the fruit.

Spring pupation of the larvae began in 1929 in the first week in April and continued until June, approximately half being transformed by the first week in April.

LENGTH OF LIFE PERIODS

Egg

The most conspicuous stages of the egg development appear several days after laying. Without considering the various embryological changes, it may be stated that the first external signs of life appear in the eye spots, which become apparent when the egg is about half or two-thirds developed. The final or "black spot" stage appears shortly before hatching. During the latter period, part of the egg becomes dark, due to pigmentation of the head and thoracic shield which give the whole a decided black appearance. The appearance of these stages depends upon temperature and the true black spot may under high temperatures occur very shortly before hatching. In cool periods it often lasts for a day or more. The eye spots normally appear several days before the egg "black-spots." Thus in an incubation period lasting six days, eye spots appeared on the fourth day. In eggs incubated at 75 and 80° F. the black spot stage appeared four to six hours before hatching on the last day of incubation.

These stages are convenient in insectary work since eggs may be held until almost ready to hatch before placing on suitable food. The eye spots enable one to recognize whether the egg is developing normally.

Peterson and Haeussler (45) state that the egg develops in 3.5 to 6 days in warm weather, 7 to 14 days in cool periods and 20 to 43 days in continuous cool weather experienced in the fall. Our records indicate an average of nine days for the first brood, five days for the second, five for the third, and 7.6 for the fourth. If the temperature is held to 60° F. or below, the incubation period increases accordingly and it is very likely that eggs laid in September would in all probability remain two weeks or more before hatching and the larval development would likewise be slow afterwards. Our experience indicates that eggs will hatch in 3.5 to 4 days at 90° F., but require 12 to 15 days when the thermometer remains at about 60.°

Larva

The length of the larval feeding period averaged in 1925-26 15.6 days for the first brood, 12.8 days for the second and 18.1 days for the third. Quality of the food makes considerable dif-

ference in the length of the stage, it being noted that a single instar reared on some of the prepared foods experimented with, required as much time as the entire larval period on normal foods. We know also that larvae fed on apples require a longer period to mature than those fed on peaches. The life cycle in quinces has, however, not been studied carefully.

Cocoon and Pupa

The time spent in constructing the cocoon varies from two to four days in midsummer. For the first and second broods this is approximately two days. For generations that hibernate, this is, of course, much longer. The pupal period averaged about 11 days for the first, second and third generations in 1925 and 1926. The period in spring, however, is somewhat longer.

Adult Moth

The female begins to lay eggs two to four days after emergence. Mating usually takes place within two days after emergence. There is then a period of about a week[1] when the eggs are deposited, and the adult may continue to live as much as a week longer. In field cages (Plate X, a) they have been observed to live for two to three weeks, while in smaller cages they rarely live more than 10 days. The maximum egg deposition occurs on the third and fourth days after emergence in midsummer.

LABORATORY EXPERIMENTS

Control of the Eggs

During 1928, preliminary tests were carried out with white oil emulsions containing various impregnating materials. These tests showed a high mortality for eggs sprayed with white oil plus pyrethrum soap, indicating at least 15 per cent better kill for such a combination than was formerly obtained with nicotine sulfate and soap as reported by Stearns (61). The work was continued in 1929 and the results are shown in Tables 2 to 11. The figures indicate that some of the commercial white oils on the market give a very good kill without additions, but that in general they average slightly higher when combined with the materials mentioned. It will be noted that these tests were made from June to August during the usual spray range for Elberta peaches and include eggs of many stages of development. In all about 7,000 eggs were used together with a total of more than 400 for 1928. No checks are shown in the tables, although some were used with

[1] Longer under some conditions.

TABLE 1. LIFE HISTORY DATA ON THE ORIENTAL PEACH MOTH, 1925-1926

Incubation of the Egg—Days

Date	First Brood No. observed	First Brood Average	First Brood Range	Second Brood No. observed	Second Brood Average	Second Brood Range	Third Brood No. observed	Third Brood Average	Third Brood Range	Fourth Brood No. observed	Fourth Brood Average	Fourth Brood Range	Total observations
1925	276	9.0	3–13	155	4.8	4–6	39	4.9	4–6	34	7.6	6–11	
1926	268	9.3	6–16	125	4.9	2–6	142	5.3	3–7				
Aver. for 1925-6..	544	9.1	3–16	280	4.8	2–6	181	5.1	3–7	34	7.6	6–11	839

Larval Feeding Period—Days

Date	First Brood No. observed	First Brood Average	First Brood Range	Second Brood No. observed	Second Brood Average	Second Brood Range	Third Brood No. observed	Third Brood Average	Third Brood Range	Total observations
1925	26	15.4	13–20	42	13.2	10–17	16	16.5	12–28	
1926	63	15.8	12–27	64	12.4	10–21	92	19.8	14–34	
Aver. for 1925-6..	89	15.6	12–27	106	12.8	10–21	108	18.1	12–34	403

Cocooning and Pupal Period—Days

Date	First Brood No. observed	First Brood Average	First Brood Range	Second Brood No. observed	Second Brood Average	Second Brood Range	Third Brood No. observed[1]	Third Brood Average	Third Brood Range	Total observations
1925	17	13.4	9–17	36	13.3	9–16	11	13.2	12–16	
1926	78	12.8	8–15	72	12.5	8–18				
Aver. for 1925-6..	95	13.1		108	12.9	8–18	11	13.2	12–16	214
Egg to Adult....	Sum	37.8	23–60		30.5	20–45	11	36.4		

Total Period[2]—Egg to Adult—Days

Date	First Brood No. observed	First Brood Average	First Brood Range	Second Brood No. observed	Second Brood Average	Second Brood Range	Third Brood No. observed	Third Brood Average	Third Brood Range	Total observations
1925	30	35.2	29–43	66	32.4	29–38	22	281.7	271–294	
1926	102	39.0	31–49	80	30.3	26–37	56	286.8	259–318	
Aver.	132	37.1	29–49	146	31.3	26–38	78	284.2	259–318	356

[1] Only those emerging before winter are recorded.
[2] Records of continuous periods from egg to adult.

each test, because at no time did more than 10 per cent fail to hatch. The average mortality of all checks was five per cent. It should also be remarked that very favorable results were obtained with one per cent oils containing about 20 per cent of steam distilled pine oil (straw color); in fact, a higher kill was obtained with this than with any other combination. Oleoresin capsicum-soap emulsions also seemed to have some killing power, as shown in Table 10. Judging from the amount of control secured with white oil emulsions, these materials should show some control in the field and this has been substantiated in part by our 1929 results. The degree of control, however, in these tests has not been any better than was previously obtained with nicotine preparations, but owing to differences in methods of applications and time of applications ought not, perhaps, to be compared.

The laboratory tests described were conducted in an outdoor insectary with eggs produced under artificial conditions. All tests were handled the same way, the sprays being applied with a small atomizer. The same nozzle was used each time and the peach leaves containing the eggs were pinned to a rack in the open insectary that had good ventilation, but was protected from sunlight.

TABLE 2. EXPERIMENTS WITH SPRAYS TO KILL THE EGGS OF THE ORIENTAL PEACH MOTH IN 1929

Lubricating Oils

Exp. No.	Materials	Eggs laid	Treated	Examined	No. dead	Hatched	Per cent killed
38	W. O. E.,[1] light 6 gm.						
	Water to 600 cc.	June 17	June 19	June 24	73	9	89
24	W. O. E., 6 gm.						
24	Water to 600 cc.	May 30	June 3	June 10	108	6	94
11	W. O. E., light 4 gm.						
	Water to 600 cc.	May 27	May 29	June 3	15	3	83
35	W. O. E., light 3 gm.						
	Water to 600 cc.	June 11	June 12	June 18	47	26	64
30	White Oil A, 6 gm.						
	Soap 2 gm., Water to						
	600 cc.	June 8, 9	June 11	June 18	71	7	91
44	W. O. E., light 6 gm.						
	Water to 600 cc.	July 12–14	July 16	July 22	171	54	76
48	W. O. E., light 6 gm.						
	Water to 600 cc.	July 13	July 17	July 22	88	23	79
49	W. O. E., Conc. 6 gm.						
	Water to 600 cc.	July 13	July 17	July 22	149	8	94
53	W. O. E., Conc. 6 gm.						
	Water to 600 cc.	July 24	B. Spot	July 30	100	18	84
54	W. O. E., light 12 gm.						
	Water to 600 cc.	July 24	B. Spot	July 30	90	5	94
56	W. O. E., Conc. 6 gm.	July 23	July 24	July 30	67	15	81
	W. O. E., Conc. 6 gm.	B. Spots	Aug. 27	Aug. 29	35	12	74
	W. O. E., Conc. 6 gm.	Aug. 22	Aug. 24	Aug. 29	77	13	85

[1] W. O. E.—A commercial white oil emulsion; light—viscosity of oil 50 sec.; concentrate, 108 sec. White oil A—a white lubricating oil of 90 sec. viscosity with 96 per cent. unsulfonatable.

TABLE 3. Lubricating Oils, Laboratory Made Emulsions

Exp. No.	Material	Total oil content	Date eggs laid	Treated	Eggs examined	No. dead	No. hatched	Per cent dead
131	20% pine oil, 80% white oil A Mineral oil soap	.5%	May 24–25	May 28	June 4	30	4	88
135	Same	.5%	May 28–29	May 31	June 4	158	21	88
138	20% pine oil, 80% white oil A Milk	.5%	May 31	June 4	June 11	38	4	90
161	20% water white pine oil, 80% white oil A Milk	.5%	June 19	June 20	June 25	63	8	88
163	Same	.5%	June 22	June 25	June 29	57	0	100
179	Same	.5%	July 9	July 10	July 15	27	0	100
194	Same	.5%	July 16	July 17	July 24	96	17	85
202	Same	.5%	July 20	July 22	July 27	184	35	84
225	Same	.5%	July 25	July 27	July 31	74	18	80
189	Same	1.0%	July 12–14	July 16	July 22	76	3	96
	Pure Oils							
150	Pine oil-milk	1.0%	June 8–9	June 11	June 17	68	27	71
151	Water white kerosene-milk	1.0%	June 10	June 11	June 17	68	11	86
146	Oil A-milk	1.0%	June 5	June 7	June 13	92	3	96
166	Same	1.0%	June 22	June 25	June 29	46	20	69
191	Same	1.0%	July 13–14	July 17	July 22	92	6	94
198	Same	1.0%	July 16	July 19	July 24	82	8	91
211	Same	1.0%	July 24	July 25	July 30	59	20	74
241	Oil A-milk	1.0%	July 31	Aug. 2	Aug. 7	155	0	100
264	Oil B-milk	1.0%	Aug. 19	Aug. 20	Aug. 26	90	4	95
279	Same	1.0%	Aug. 23	Aug. 26	Aug. 30	175	9	95
153	Oil B-milk	1.0%	June 12	June 13	June 18	91	3	96
167	Same	1.0%	June 22	June 25	June 29	45	7	86
192	Same	1.0%	July 13–14	July 17	July 22	120	0	100

TABLE 3. Lubricating Oils, Laboratory Made Emulsions (Continued)

Exp. No.	Material	Total oil content	Date eggs laid	Treated	Eggs examined	No. dead	No. hatched	Per cent dead
199	Same	1.0%	July 16	July 19	July 24	76	19	80
210	Same	1.0%	July 24	July 25	July 30	85	13	86
242	Same	1.0%	July 31	Aug. 2	Aug. 7	252	3	98
265	Same	1.0%	Aug. 19	Aug. 20	Aug. 26	87	5	94
209	56-oil-milk	1.0%	July 24	July 25	July 30	68	22	75
240	Same	1.0%	July 31	Aug. 2	Aug. 7	125	7	94
262	Same	1.0%	Aug. 19	Aug. 20	Aug. 26	103	1	99
280	Same	1.0%	Aug. 23	Aug. 26	Aug. 30	101	4	96
291	Same	1.0%	Aug. 28	Aug. 30	Sept. 9	216	16	93

Notes

Oils used	Per cent unsulfonatable	Viscosity Saybolt
56 oil	97	58
White oil A	96	90
White oil B	98	160

Pine oils in Nos. 131, 135, 138 and 150 straw-colored; in all others, water white.

TABLE 4. EXPERIMENTS WITH SPRAYS TO KILL THE EGGS OF THE ORIENTAL PEACH MOTH, 1929

Lubricating Oils with Additional Contact Insecticides

1. Pyrethrum products

Exp. No.	Materials	Eggs laid	Eggs treated	Eggs examined	No. dead	No. hatched	Per cent killed	Notes
1	W. O. E.,[1] 1.6 gm., Pyrethrum soap, 1 gm., Water to 600 cc.	May 23	May 24	May 29	24	3	89	
16	Same as 1	May 28	May 30	June 10	85	13	86	
50	W. O. E., conc. 6 gm., Pyrethrum soap, 1 gm., Water to 600 cc.	July 13	July 17	July 22	93	4	96	Actual kill, including dead larvae, 98%
51	W. O. E., light 6 gm., Pyrethrum soap, 1 gm., Water to 600 cc.	July 13	July 17	July 22	109	9	92	
52	W. O. E., conc., 6 gm., Pyrethrum soap, 1 gm., Water to 600 cc.	B. spot	July 24	July 30	187	11	94	
55	W. O. E., conc., 6 gm., Pyrethrum soap, 1 gm., Water to 600 cc.	July 23	July 24	July 30	152	10	94	
	W. O. E., conc., 6 gm., Pyrethrum soap, 1 gm., Water to 600 cc.	Black spots	Aug. 27	Aug. 29	61	9	87	
	W. O. E., conc., 6 gm., Pyrethrum soap, 1 gm., Water to 600 cc.	Aug. 22	Aug. 24	Aug. 29	103	12	89	2 dead on leaves after *hatching*. Actual kill 90%

[1] *White oil emulsions.*

TABLE 5. Lubricating Oils with Additional Contact Insecticides

2. Derris and similar materials

Exp. No.	Materials	Eggs laid	Eggs treated	Eggs examined	No. dead	No. hatched	Per cent killed
34	W. O. E.,[1] 1.3 gm., Derris preparation, 1 gm., Water to 600 cc.	June 11	June 11	June 18	27	18	60
18	W. O. E., 1.6 gm., Derris preparation, 1 gm., Water to 600 cc.	May 28	May 31	June 10	33	15	68
33	W. O. E., 1.3 gm., Rotenone (10%), .5 cc., Water to 600 cc.	June 11	June 12	June 18	63	23	73

[1] White oil emulsion.

TABLE 6. Lubricating Oils with Additional Contact Insecticides

3. Nicotine products and substitutes

Exp. No.	Materials	Eggs laid	Eggs treated	Examined	No. dead	No. hatched	Per cent killed	Notes
12	W. O. E.,[1] 1.6 gm., Free nicotine, 1 cc., Water to 600 cc.	May 22	May 25	May 29	13	4	76	Av. 86%
	"	June 17	June 19	June 24	92	11	89	
4	W. O. E., 1.6 gm., Nic. sulf., 1 cc., Water to 600 cc.	May 22	May 25	May 29	15	3	83	Av. 85%
17	Same	May 28	May 30	June 10	110	2	98	
45	W. O. E., 1.6 gm., Nic. sulf., 1 cc., Water to 600 cc.	July 12, 14	July 16	July 22	105	32	76	

[1] White oil emulsion, commercial.

TABLE 7. Lubricating Oils with Additional Contact Insecticides

4. Pine oils and miscible pine oils

Exp. No.	Materials	Eggs laid	Eggs treated	Eggs examined	No. dead	No. hatched	Per cent killed
23	White oil emulsion, 1.3 gm., Miscible pine oil, 1 cc., Water to 600 cc.	May 30	June 3	June 10	81	29	73
25	White oil, 5 cc., Pine oil, 1 cc., Soap, 2 gm., Water to 600 cc.	May 30	June 3	June 10	87	1	98
31	"	June 8, 9	June 11	June 18	52	1	98
189	White oil, 3 gm., Pine oil, 2 gm., Milk emulsifier, Diluted to 1% oil	July 12, 14	July 16	July 22	76	3	95

NOTES: White oil used had viscosity of 90 sec. No. 23, a commercial emulsion; Nos. 25, 31, and 189, laboratory made emulsions. Pine oil—steam distilled, straw color.

TABLE 8. Lubricating Oils with Additional Contact Insecticides

5. Oleoresin capsicum

Exp. No.	Materials	Eggs laid	Eggs treated	Eggs examined	No. dead	No. hatched	Per cent killed
32	90 visc. white oil, 5 gm., Ol. cap., 1 gm., Water to 600 cc., Soap, 2 gm.	June 8–9	June 11	June 18	32	3	91
37a 37b	90 visc. white oil, 3 gm., Ol. cap., 5 cc., Soap, 2 gm., Water to 600 cc.	June 15–16	June 17	June 24	197	19	91

TABLE 9. MISCELLANEOUS MATERIALS

Exp. No.	Materials	Eggs laid	Eggs treated	Eggs examined	No. dead	No. hatched	Per cent killed
6	Free nic., .2 cc., Soap, 2.0 gm., Water to 200 cc.	May 25	May 28	May 31	6	10	37
8	Penetrol, 1 cc., Water to 200 cc.	May 26	May 28	May 31	2	20	9
12	Dipyridils, .5 cc., Soap, 1.0 gm., Water to 200 cc.	May 27	May 29	June 3	1	13	7
14	Miscible pine oil, 1 cc., Water to 100 cc.	May 27	May 29	June 3	1	12	7
15	Miscible pine oil, 1 cc., Water to 100 cc.	May 26	May 29	June 3	1	12	7

TABLE 10. OLEORESIN CAPSICUM EMULSION

Exp. No.	Materials	Eggs laid	Eggs treated	Eggs examined	No. dead	No. hatched	Per cent killed
26	Ol. cap., 1 cc., Soap, 1 gm., Water to 100 cc.	June 1, 2	June 3	June 12	44	11	80
28	Ol. cap., 1 cc., Soap, 2 gm., Water to 500 cc.	May 31 June 3, 4	June 5	June 14	21	34	38
29	Ol. cap., 1 cc., Soap, 1 gm., Water to 100 cc.	June 7	June 11	June 15	77	20	79

TABLE 11. ROTENONE

Exp. No.	Materials	Eggs laid	Eggs treated	Examined	No. dead	No. hatched	Per cent killed	Notes
40	Rotenone (10%), 1 cc., Syrup, 2 gm., Water to 100 cc.	June 16, 17	June 20	June 26	24	7	77	Probable efficiency about 93% on account of larval mortality after hatching
41	Rotenone (5%), 1 cc., Syrup, 2 gm., Water to 100 cc.		June 28	June 29	90	75	54	13 larvae found dead on leaves, bringing actual kill to about 61%

Control of Larvae

Except in the earlier instars, the larva of the Oriental peach moth is very difficult to kill. Older larvae will pass through almost any poison barrier short of metallic arsenic or arsenic pentoxide, so that from a practical standpoint the older larvae are invulnerable. The newly-hatched larvae are, on the other hand, more susceptible and should be, in theory at least, easily checked. The use of mechanical barriers such as lime and talcum powder depend on the fact that particles of these materials adhere to the surface of the newly-hatched larva and cause it to drop from the tree. Experiments with very young larvae placed on peaches dusted with different materials show that 90-10 arsenate sulfur dust, various fluosilicates and fluorides and impregnated dusts containing pyrethrum and eight per cent dipyridyl sulfate have considerable effect in preventing entrance. One of the most striking results was obtained with a special pyrethrum dust which apparently killed all larvae coming in contact with it. Not much is known of the costs of some of these materials and they have not as yet been used in field experiments. The results are shown in Table 12.

Control of hibernating larvae after spinning would be desirable if such could be accomplished economically without harm to the tree. During 1929, preliminary tests were made with hibernating larvae in paper cells that were treated with a number of materials. These tests show good killing power for certain emulsions containing 20-30 per cent pine oil in emulsified form, but this is probably too much oil for the ordinary peach tree to withstand. These results are shown in Table 13. In this connection several of the constituents of pine oil were tried and showed considerable action for limonene and terpineol, but very little for dipentene and pinene. See Table 15. Following this clue, sweet orange oil containing considerable limonene was tried and showed again considerable killing power. Our tests also demonstrate that pure gasoline or kerosene are highly destructive to larvae spun in paper cells. In addition to these, several tar acid oils were used upon larvae spun on pear branches, with fair results at 3 per cent. Experiments by Ross (55) indicate that 10 to 15 per cent tar acid oils are necessary to kill the over-wintering larvae, and the above results seem to substantiate this. Doubtless a higher percentage of crescylic acid would increase the kill to the figures he obtained.

TABLE 12. TESTS OF VARIOUS INSECTICIDES TO POISON OR PREVENT ENTRANCE OF THE NEWLY HATCHED LARVAE OF THE PEACH MOTH

No. larvae or eggs	Number of tests	Average per cent entered	Materials used and formulae
			Arsenicals
70	4	4.2	90–10 sulphur-arsenate dust
			Fluosilicates and Fluorides
31	2	6	Cal. fluosilicate 1926 product
45	3	6	Magnesium fluoride pure
10	1	10	Sodium fluosilicate—lime dust, 1 part—4 parts lime
93	1	25 (10–18%)[1]	Sodium fluosilicate—lime dust, 1 part—10 parts lime
			Hydrated Lime
42	1	73	Pure hydrated lime dust
32	2	36	Pure hydrated lime dust
			Talc Dust, Fibrous
41	1	51 (41)[1]	Pure talc dust
64	1	62	Pure talc dust
			Dipyridyl Sulphate Dusts
43	1	16 (6)[1]	8% dipyridyl sulfate in an inert carrier
47	1	23 (0)[1]	8% dipyridyl sulfate in an inert carrier
22	1	0	8% dipyridyl sulfate in an inert carrier
23	1	69	1 gm. dipyridyl sulfate, 30 gms. lime, 600 cc. water—sprayed
			Pyrethrum Dust
23	1	0	50% pyrethrum extract, 20 dead larvae found in stem ends
23	1	0	23–30% pyrethrum extract, 16 dead in stem ends
35	3	54.2	None
12	1	100	"
10	1	90	"
5	1	80	"
41	1	90	"
11	1	57	"
32	1	59	"
18	1	50	"
199	10	56	

[1] Actual percentage entered after deducting the infestation in the peaches in the beginning. Ripe or nearly ripe peaches were used and it was impossible to obtain fruit entirely free of worms. Percentage deducted represents infestation of a representative sample. Experiments all conducted by placing eggs cut from leaves in the stem ends of dusted or sprayed fruit.

TABLE 13. EXPERIMENTS IN KILLING THE OVERWINTERING LARVAE OF THE ORIENTAL PEACH MOTH, 1929

Miscible Pine Oils and Pine Oil Emulsions

Exp. No.	*Material*	Dates	Per cent killed	Notes
1	Miscible[1] pine oil, 50% emulsion	April 10–15	100	
2	Miscible[1] pine oil, 33% emulsion	April 10–15	100	
3	Miscible[1] pine oil, 20% emulsion	April 10–15	88	
4	Miscible[1] pine oil, 15% emulsion	April 17–22	66	
5	Miscible[1] pine oil, 10% emulsion	April 10–June 21	66	
6	Miscible[1] pine oil, 10% emulsion	May 20–May 25	92	Different stock
7	Sol. pine oil, 20% emulsion	April 24–29	86	
8	Form. 87, 20% pine oil	April 22–26	88	
9	Form. 87, 20% pine oil	April 27–May 3	100	
10	Form. 88, 10% pine oil	April 22–26	00	
11	Form. 74, 3% pine oil	Feb. 25–June 21	50	
12	Check, no treatment	Feb. 25–June 25	00	
13	Form. 93, 2.5% pine oil plus pyrethrum 10%	May 6–June 21	100	9 pupae in this lot; 4 dead; 4 larvae—all dead
14	Form. 93, 10%	May 17–June 25	100	
15	Form. 93, 5%	May 17–June 24	97	
15a	Form. 93, 5%	May 17–June 25	100	

[1] NOTES: Miscible pine oil at 20 per cent sprayed on two peach trees at the Mount Carmel farm on April 23 after buds had reached pink. Many buds were killed but new growths started nicely on May 3.

The method used consisted of dipping the larvæ, spun in paper cells, in each material, blotting off the excess liquid and removing to the insectary where they were kept in open containers.

TABLE 14. MISCIBLE KEROSENE AND COMBINATIONS

Exp. No.	Material	Dates	Per cent killed	Notes
16	Miscible kerosene 5%, naphthalene .1%	April 12–22	9	Pupae
17	Miscible kerosene 10%	April 12–June 21	00	
18	Miscible kerosene 15%	April 17–June 24	44	2 pupae
19	Miscible kerosene 10%, naphthalene .2%	April 12–June 21	50	No pupae
20	Miscible kerosene 10%, ethyl acetate .1%	April 17–June 24	9	
21	Miscible kerosene 10%, carbon disulfide .1%	April 17–June 24	0	
22	Miscible kerosene 10%, beta-naphthol .1%	April 10–June 15	0	No pupae
23	Miscible kerosene 10%, naphthalene 1.0%	April 29–June 24	22	Pupae

TABLE 15. EXPERIMENTS IN KILLING THE OVERWINTERING LARVAE OF THE ORIENTAL PEACH MOTH WITH VARIOUS SUBSTANCES, 1929

Mineral Oils and Combinations

Exp. No.	Material	Dates	Per cent killed	Notes
24	Gasoline 80%, pine oil 20%	Feb. 25–June 21	100	
25	Gasoline 50%, pine oil 50%	Feb. 13–April 10	100	
		Feb. 25–April 10		
26	Gasoline, pure	Feb. 25–April 10	91	
27	Kerosene (best grade), pure	May 5–June 24	100	8 pupae in this lot
28	Fuel oil	Feb. 25–April 10	50	
29	Kerosene	Feb. 25–April 10	100	
30	Kerosene 50%, fish oil 50%	Feb. 11–June 24	70	
31	Same, emulsified and diluted to 41% oil	Feb. 11–June 24	62	
32	Check, no treatment		00	

TABLE 16. EFFECT OF SWEET ORANGE OIL AND VARIOUS PINE OIL CONSTITUENTS ON THE OVERWINTERING LARVAE, 1929-1930

Materials	Per cent oil in diluted emulsion	Date	No. larvae or pupae	Per cent dead
Check, no treatment ...	..	1929	5 larvae	0
		1930	18 larvae	5
Soap 2%	..	1929	21 pupae	21
		1930	10 larvae	20
Dipentene	10	1929	86 pupae	1
Soap 2%	9	1930	29 larvae	17
Pinene	10	1929	23 pupae	27
Soap 2%	9	1930	28 larvae	42
Sweet orange oil	10	1929	4 larvae	100
Soap 2%	9	1930	26 larvae	88
	10	1929	16 pupae	100
Terpineol	10	1929	105 larvae	97
Soap 2%	9	1930	32 larvae	90
d--Limonene	10	1929	14 larvae	100
Soap 2%	10	1929	66 pupae	98
	9	1930	32 larvae	100

NOTES: All tests were made with larvæ or pupæ in paper cells; 1929 treated May 20-29, examined June 21; 1930 treated Feb. 12, examined Feb. 20. Terpineol used at 10 per cent strength on peach foilage burned severely, limonene and pinene burned slightly, and orange oil and dipentene even less.

Control of the Moth

Two methods are available for control of the moth, namely, poisoning and repellent action to prevent egg laying. An attempt to poison adult moths was made in 1929 by adding rotenone to syrup and spraying it on leaves within oviposition cages. The results obtained are shown in Table 17 and indicate a decided reduction in number of eggs. In only one of the tests was it apparent that any poison was taken by the moths themselves. Our repellent tests have been confined to cage and small field tests; the field tests of 1928 with alpha-naphthylamine reversed results obtained in cage tests. Field technique with these materials has not yet been perfected, so that further discussion of results is not advisable at this time. The main difficulty with most repellents lies in their volatility, which causes them to disappear from the tree within a short period. Doctor Lipp, of the United States Department of Agriculture, has done much work with repellents and has devised a means for testing materials of this sort. In laboratory tests he found bone oil and alpha-naphthylamine very efficient (34).

TABLE 17. TESTS IN PREVENTION OF EGG-LAYING BY APPLICATIONS OF ROTENONE AND SYRUP

Dates	Notes on experiments	No. eggs obtained on— Treated	Untreated
July 19–24	Large number of moths in cage about 6" square, two shoots sprayed with rotenone (1.5 cc. 10% in acetone) in 200 cc. water, 2 gm. refiners' syrup added, two shoots untreated in opposite corners of cage. Moths crowded probably accounting for the fairly large number on treated shoots.	763	1719
June 13	50 moths in two different cages of same size, one with peach shoots treated with 1 cc. 10% acetone solution plus 1 gm. honey in 100 cc. water. June 17, three moths or 6% were alive in cage with treated shoots; 19, or approximately 50%, were alive in untreated	76	288
June 18	Same as on June 13. June 24, 6 moths were alive in treated cage, 12 in check ...	15	203
June 24	Same as June 18 and 13, using syrup instead of honey, about 25 moths in each cage. June 29, three alive in both cages..	0	7
	Total	854	2217

FIELD CONTROLS

History

Shortly after the discovery of the moth in 1917, an investigation of controls in the District of Columbia, Maryland and Virginia disclosed the fact that the ordinary arsenical lime sulfur sprays (self-boiled) were not adequate, because of injury to the tree and the several brooded nature of the pest. Nicotine sulfate was next advocated by Virginia (61) and taken up in New Jersey. By this means about 10 per cent reduction in injury may be obtained, but this is not sufficient and it is considered too expensive by orchardists for the results obtained. Turning now to other means, Ohio (69) studied the use of hydrated lime in large quantities, but this material has not been entirely successful and has not worked well in our field experiments. Likewise, talc dust has been used in New Jersey (10) with considerable promise, but has not yet given satisfactory results in Connecticut. Both this and lime sprays should, however, be considered as still in the experimental stage.

It was found also that pans containing fermented molasses attracted many moths, so this too was used as a control, with little or no success to date. The reason for this failure lies probably in the fact that only a small percentage of the moths in an orchard are captured by this method. For example, bait pans hung in a

cage provided with moths caught very few and eggs were deposited within a few feet of the baits. Stear (58) reports 4-30 per cent catch of marked moths liberated in an orchard where pans were maintained. Much work has been done towards perfecting baits and containers by Frost (18, 19) and Peterson (42, 43) and it has been shown by these workers that enamel or protected pans containing one-half gallon or more give the best results. The best bait appears to be a cheap grade of molasses or refiners' syrup diluted one part in 20 parts of water. For our conditions a refiners' syrup has given good results. Bait pans, in spite of their failure to date in giving satisfactory control, are useful in indicating the extent of the different broods and in telling the orchardist whether moths are abundant in his orchard.

Control Experiments in Connecticut

Our first experiments in control of the Oriental peach moth in Connecticut consisted of various nicotine and arsenical applications, which gave the results shown in Table 18. These were conducted in a large orchard near Greenwich in southwestern Connecticut. The spraying equipment is seen in Plate XII. The fruit was graded from exterior examination, but a representative number from each plot was cut open, and the number missed on the first examination was then estimated. The percentages appear in the last column.

TABLE 18. RESULTS OF SPRAY EXPERIMENTS TO CONTROL THE ORIENTAL PEACH MOTH AT CONYERS FARM, 1924. VARIETY, BELLE OF GEORGIA

Block	Treatment	Good	Infested	Per cent	Per cent infested based on cut fruit
1	Fungicide only, 2 sprays	3237	393	10.8	23
2	Five sprays with nicotine sulfate. Two of these with arsenate	2528	190	6.9	14
3	Fungicide plus lead arsenate	3539	408	10.3	..
4	Five dusts containing nicotine, 2 with arsenate	1847	63	3.2	11

This work was continued in 1925 in two different orchards and complete records were kept of the fruit examined, all being cut open. These figures show that that old or second brood injury is about one-third or one-fourth the total injuries, but that none of the scheduled applications were especially successful. Table 19 shows results obtained in the Barnes orchard at Wallingford, and Table 20 those at Conyers Farm in Greenwich.

TABLE 19. RESULTS OF SPRAY EXPERIMENTS TO CONTROL THE ORIENTAL PEACH MOTH, BARNES ORCHARD, 1925. VARIETY, ELBERTA

Block No.	Treatment	Total fruits	Per cent infested
1	90-10 dust, July 15, Aug. 14	824	37.8
2	Nicotine dust, July 15, July 30, Aug. 14	755	27.9
3	Check	439	46.7

Table 19 shows a considerable reduction for nicotine dust. The results obtained at Conyers Farm contradict this, although in the previous season they were more favorable. Thus in 1924 we obtained a reduction of 12 per cent by this means, whereas in 1925, after shifting the block to a more unfavorable location, no reduction was obtained. Here the most favorable treatment was found to be nicotine sprays, which netted a reduction of 12 per cent. It becomes apparent, therefore, that nicotine sulfate, either in the form of a spray or dust, will reduce injury from the peach moth, for in spite of one failure, there are three successes in our field experiments. The amount of injury reduction varied from 12 per cent with a 23 per cent infestation to about 18 per cent with a total check infestation of 46.7 per cent. In the Barnes orchard, however, this left 27.9 per cent infested fruit in the nicotine dusted plot, which is too much from a commercial standpoint.

TABLE 20. RESULTS OF SPRAY EXPERIMENTS TO CONTROL THE ORIENTAL PEACH MOTH AT CONYERS FARM, 1925. VARIETY, BELLE OF GEORGIA

Block No.	Treatment	Total fruits	Per cent injured
1	Nicotine dust (2.7%) July 13, July 29, Aug. 10	1964	22.9
2	90-10 sulfur arsenate dust, July 13, Aug. 10	1932	15.5
3	Check	1924	21.5
4	Nicotine sulfate spray, July 13, July 29, Aug. 10, Aug. 20	1883	10.5

In 1927, a block of about 50 trees at Wallingford was sprayed twice in July with sodium fluosilicate, glue, lime and water, followed by two applications of white oil emulsion, to which was added nicotine sulfate half strength and oil of citronella. The following results were obtained:

TABLE 21. RESULTS OF SPRAYING TO CONTROL THE ORIENTAL PEACH MOTH AT WALLINGFORD, 1927. VARIETY, ELBERTA

Treatment	Total fruits	Per cent old injury	Per cent new injury	Total per cent injured
Sprayed	702	3.9	5.3	9.2
Check—Sulfur dust only	747	8.3	6.2	14.5

It may be added that the sprayed plot here was in an unfavorable location, indicating that the reduction in old and new injury does not necessarily show the value of the treatments. There is some reduction both in old and new injury, however. In 1929, after a lapse of one year, field work was again undertaken, due to the development of talc dusts and heavy lime sprays in the meantime. Also it was thought advisable to test oils with additional materials as controls. An orchard of about four acres was leased at Mount Carmel and work conducted throughout the season. The following results were obtained after cutting all fruit from five selected trees.

TABLE 22. RESULTS OF SPRAYING TO CONTROL THE ORIENTAL PEACH MOTH AT MOUNT CARMEL, 1929. VARIETY, ELBERTA

Block No.	Treatment	Total fruits	Per cent injured fruit	Per cent fruit injury to check trees in each block
1	Talc dust, 10 applications	1402	28.2	25.2
2	White oil emulsion,[1] light, with nicotine sulfate, 5 sprays in August and September at weekly intervals	768	16.0	28.0
3	W. O. E.,[2] concentrate with pyrethrum soap, 5 sprays in August and September at weekly intervals	535	19.4	19.5
4	Lime, 5 applications in June and July at 10-day intervals	1569	19.9	20.2
5	Check, no treatment	1420	22.2	...

In addition to the figures given above, an experiment was carried on in a small plot of about twenty trees on the Experiment Station farm, using a commercial white oil emulsion in comparison with no treatment. This is shown in Table 23.

TABLE 23. EXPERIMENT TO CONTROL THE ORIENTAL PEACH MOTH, STATION FARM, 1929. VARIETY, ELBERTA

Treatment	Total fruits	Per cent injured
W. O. E. conc. 1%, .8% oil, 4 sprays in August, 1 in September	658	7
Check, no treatment	699	20

Several quince trees were also sprayed with white oil emulsion (concentrate) during August and September, 1929, at weekly intervals. These fruits were picked about October 1, and the number of exit holes counted on the sprayed and the unsprayed fruit. There were fewer such marks on the sprayed quinces, although the amount of infested fruit was about the same. In

[1] Commercial preparation, 1.5 per cent oil in diluted spray. Viscosity of oil 50 sec.
[2] Commercial preparation, .8 per cent oil in diluted spray. Viscosity of oil 108 sec.

1928 two orchardists sprayed and dusted their quinces (sulfur-arsenate 90-10 dust and lead arsenate in combination with dry mix) at 10 days intervals in August. The treatments apparently gave no control. In the case of quinces there is the whole of September when reinfestation might occur, but it seems inadvisable with poison sprays to continue applications too late, on account of harmful residue that may remain at harvest. Oil sprays might possibly be continued except for the expense which would (at present costs), after many applications easily consume whatever profit there is in the fruit and certainly would not pay unless their effectiveness is considerably increased.

In 1926 and 1927 bait pans were used in a large orchard in Wallingford and the fruit scored at harvest by cutting open a representative number. Results are given in Table 24.

TABLE 24. TESTS WITH BAIT PANS AS A CONTROL FOR THE ORIENTAL PEACH MOTH, 1926 AND 1927. VARIETY, ELBERTA

Treatment[1]	Total fruits	Per cent injured
1927		
Pail in every tree	775	13.9
Check, dust only	747	14.5
1926		
Pail in every tree	1024	12.7
Pail in every other tree	1370	9.7
Check, dust only	928	10.5

The theory of this means of control is that moths are attracted to fermenting baits, fly into the liquid and are unable to escape. When tbe moths are most numerous in the orchard, thousands may be caught in the pans. It is believed that the fermenting sugars are necessary and it has been proved that tin pails are not as satisfactory as enamel or glass containers, because of the reaction of the liquids on the metal. Suitable enamel pails may be purchased as low as 15 cents each and for practical purposes (determination of broods) cheap molasses can be used. This should preferably be renewed once a month and the pails kept filled with water frequently during dry periods. A dilution of one part molasses in 20 parts water with or without yeast is satisfactory.

Control in Twigs

During 1919, the writer conducted some experiments on the grounds of the Maryland Agricultural Experiment Station for control of the Oriental peach moth in twigs. Twelve small trees were selected and every other tree sprayed with a formula con-

[1] All trees, including those with pails, were dusted several times with sulfur dust by the owner.

TABLE 25. CONTROL OF THE ORIENTAL PEACH MOTH IN TWIGS, COLLEGE PARK, MD., 1919

Treatment	Exp. No. of tree	Number of injured shoots on following dates: May 29	June 5	July 5	July 16	Aug. 8-9	Aug. 16	Aug. 18	Sept. 1	Estimated shoots per tree	Total twigs injured
Sprayed ...	2	0	0	17	10	26	5	9	5	100	
	4	0	0	18	17	28	1	3	3	200–300	
	6	0	2	15	8	21	2	0	0	100	
	8	1	2	11	11	9	1	3	6	200–300	
	10	0	4	13	21	32	3	0	2	200–300	
	12	3	7	12	4	6	0	0	0	70	
Totals..		4	15	86	77	152	11	15	16		376
Checks	1	8	0	54	4	48	5	9	5	150–200	
	3	10	0	32	12	52	6	5	4	150–250	
	5	9	2	33	11	8	6	2	4	75	
	7	18	8	36	7	18	8	3	6	200–300	
	9	4	14	23	7	46	5	8	3	70	
	11	13	13	55	22	77	10	5	1	300–400	
Totals..		62	37	233	63	249	40	32	23		739

Notes: Dates of spray applications, May 9, May 12, May 31, June 21, July 11, Aug. 1 and Aug. 8. Sprays on May 9 and Aug. 1 contained arsenate of lead; others did not.

taining self-boiled lime sulfur, calcium arsenate, calcium caseinate and nicotine sulfate. The arsenate was used in two of the applications and the number of injured twigs counted regularly and tagged. The results are shown in Table 25. Since these figures have not been published, they are given here, with permission of the Maryland Experiment Station.

From the data in Table 25 it was concluded that sprays should be made more frequently to obtain satisfactory control, especially since the results vary and, considered from the mathematical standpoint, are doubtfully important. There is little doubt, however, that there is some reduction in number of injured twigs. In 1929, 12 small peach trees at New Haven were divided into two plots, one of which was dusted frequently with talcum powder and the other left without treatment. Injured twigs were frequently removed, care being taken to obtain all infested shoots. The results are shown in Table 26. Both ordinary and fibrous talc dusts were employed and the results revealed more injured twigs for the ordinary talc and slightly less for the fibrous talc. This corresponds in general with our field experiment with fruit, where there was no gain in sound fruit from the use of talc. Weather conditions were favorable for the tests, since there was very little rainfall.

TABLE 26. EFFECT OF DUSTING WITH TALC TO PREVENT ENTRY OF LARVAE IN TWIGS

Kind of talc	Dates treated	Date injured twigs removed	Number from dusted trees	Number from check trees
Ordinary	June 14	June 18	17	19
	June 18	June 20	29	20
	June 26	June 24	25	26
	June 29	June 26	16	15
		June 28	16	11
		July 1	16	9
Totals			119	100
Fibrous talc	July 3	July 3	5	4
	July 6	July 6	4	10
	July 12	July 9	19	24
	July 16	July 11	9	13
		July 13	25	15
		July 15	7	9
		July 19	12	12
Totals			81	87
Totals for both kinds of talc			200	187

Cultivation

Complete thorough cultivation for the peach moth has been practiced for a number of years by Connecticut growers. The best results were obtained apparently in the Barnes Orchard at Wallingford, where all ground was broken or plowed in the fall, with frequent cultivation in spring and summer up to August. There is little doubt that some good has been done by this control measure, but from observations in other orchards, where the infestation is heavy, it is apparent that such methods do not afford complete or, in some cases, even satisfactory relief. Thus in the Rogers orchard, one of the heaviest infestations yet seen in Connecticut followed a year of intensive complete cultivation. There are orchards, too, that cannot be completely cultivated, being located on hillsides where complete cultivation would do more harm than good because of erosion. On the other hand, some cultivation of peaches appears to be essential in peach culture in Connecticut and whether it is complete or partial is determined by the nature of the land and preference of the owner.

SUMMARY OF CONTROLS

1. Thus far it has been seen that arsenicals as controls are ineffective, as well as dangerous on peach trees, if applied repeatedly.
2. Nicotine sprays or dusts reduce the infestation considerably but not enough.
3. Lime sprays and talc dusts did not afford protection in our orchard in 1929.
4. White oil emulsions gave some reduction but not enough.
5. White oil emulsions with additional materials have not materially increased effectiveness in the field.
6. Materials applied against the overwintering larvae, while apparently effective in laboratory tests, have not yet been proved safe or effective in field practice.
7. Repellents are still in the experimental stage and have not yet been proved of value in field control.
8. Bait pans have not been effective so far, apparently because of the large number of moths in an infested orchard and the relatively small number caught by such means.
9. Cultivation recommended for the last few years has not given the desired relief in heavily infested orchards. There is no doubt, however, that it destroys many larvae and should therefore be continued in the general scheme of control.
10. Paradichlorobenzene will kill most of the larvae that are reached, but cannot be depended upon for complete control; and furthermore, is usually applied before the majority of the larvae spin.

RECOMMENDATIONS

The present status of the peach moth in Connecticut justifies the following recommendations. It should be recognized, of course, that only partial control will result from these measures, but we believe them advisable in view of the seriousness of the situation.

1. Cultivation: complete to trunks of trees, spring cultivation to be complete by May 15, preferably May 1; depth, four inches.
2. Prompt destruction of cull fruit and screening of packing sheds to prevent escape of moths. The fruit shed should be closed until the middle of July. Care or destruction of containers where larvae have spun.

PARASITES

In considering the damage brought about by the Oriental peach moth, it has been observed that the period of increase and decrease in certain orchards has followed a definite cycle. Beginning with a small infestation of perhaps 10 to 15 per cent, where it may remain for two or three years, it may then jump to 50 per cent or even higher, and stay there several years before it begins to decline. In some orchards the period of severe damage has persisted for three or even four years, causing great monetary loss. Connected with periods of decline there has been apparent in several different orchards a decided increase in parasites, particularly the more common *Macrocentrus ancylivora*. In other localities *Trichogramma minuta* has been observed throughout the season. *Glypta rufiscutellaris* has been abundant in some years, and in one orchard a considerable number of *Eubadizon* sp. was found. A list of about 50 parasites has been compiled by Stearns (80) and there are probably others not yet recorded. Thirty parasites are listed below from Connecticut and neighboring states.

	Parasite	Distribution	Prevalence in Connecticut
1.	*Macrocentrus ancylivora* Roh.	New Jersey, Pennsylvania, Connecticut, Maryland, Virginia, Ohio, New York	Present in considerable abundance in some orchards.
2.	*Macrocentrus delicatus* Cr.	New Jersey, Connecticut, probably others	
3.	*Glypta rufiscutellaris* Cr.	New Jersey, Connecticut, Pennsylvania, Maryland, Virginia, Georgia, Ontario	Fairly common in Connecticut.
4.	*Eubadizon* sp.	Connecticut, Georgia, Ontario, Virginia	Present in one orchard in considerable numbers.
5.	*Trichogramma minuta* Riley	New Jersey, Virginia, Maryland, Connecticut	Very abundant in some orchards.

The following parasites from nearby states have not been observed in Connecticut or are rare in our orchards:

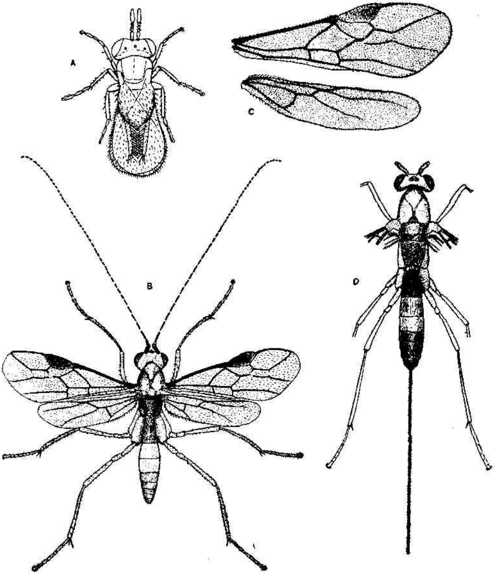

FIGURE 34. Parasites of the Oriental peach moth. A, an egg parasite, *Trichogramma minuta* Riley; B, C, D, *Macrocentrus ancylivora* Rohwer; B, male; C, wings of female; D, body of female. All much enlarged.

6.	*Ascogaster carpocapsae*	Virginia, Maryland, New Jersey, Pennsylvania
7.	*Cremastus minor* Cush.	New Jersey
8.	*Cremastus forbesii* Weed.	New Jersey
9.	*Cremastus* sp.	New Jersey
10.	*Aenoplex betulaecola* Ash.	New Jersey, Pennsylvania
11.	*Allocota thyridopterigis* Riley	Pennsylvania
12.	*Calliephialtes grapholithae* Cresson	New Jersey, Pennsylvania
13.	*Calliephialtes* sp.	New Jersey
14.	*Centeterus ineptifrons* Gahan	New Jersey, Pennsylvania, Virginia (in quinces)
15.	*Cryptus vinctus* Say.	New Jersey
16.	*Ephialtes aequalis* Prov.	Virginia
17.	*Epiurus indagator* Cress.	New Jersey
18.	*Goniozus* sp.	Virginia

19.	*Hemiteles* sp.	New Jersey
20.	*Itoplectis conquisitor* Say.	New Jersey and Pennsylvania
21.	*Leucodesmia nigriventris* Gir.	Virginia
22.	*Euzanillia variabilis* Coq.	Maryland, New Jersey, Georgia
23.	*Meteorus hyphantria* Riley	New Jersey
24.	*Microbracon gelechiae* Ash.	Virginia, New Jersey
25.	*Phanerotoma tibialis* Hald.	New Jersey
26.	*Phygadeum* sp.	New Jersey
27.	*Pristomerus ocellatus* Cush.	New Jersey
28.	*Rogas platypterigis* Ash.	Virginia
29.	*Sagaritis consimilis* Ash.	New Jersey
30.	*Sagaritis patsuiketorum*	New Jersey

In addition to the above-mentioned parasites, thrips, pentatomid bugs, spiders and ants have been observed to destroy the Oriental peach moth.

Macrocentrus ancylivora Rohwer

Plates VIII, a, IX, b; Figure 34, B, C, D.

This is the most important larval parasite at present in Connecticut. It appears early in the season in small numbers, passing the winter probably in late twig-infesting larvae of the peach moth, or in small numbers in fruit-infesting larvae. There is also a possibility that it may pass the winter in other hosts, but so far this has not been demonstrated. Fall collections of larvae in Connecticut fruit have not produced a single Macrocentrus. In New Jersey this parasite, however, attacks the strawberry leaf roller, *Ancylis comptana*, and reaches a high percentage of parasitism.[1] Since Stearns (85) has demonstrated that the two forms are the same, the strawberry leaf roller may be utilized in breeding experiments, or parasitized larvae may be collected for distribution from suitable sources.

Briefly, the life history is as follows: The eggs of the parasite are laid in the body of the peach moth larva of all stages. "Macros" will also develop in all stages of the leaf roller. Fink (79) states that the incubation period lasts from 3-13 days and that the number of eggs found in the female ovaries varies, the minimum contained being 384 and the maximum 786. If all eggs develop and are successfully deposited, each one in a single peach moth larva, the normal increase would be from two to seven times as fast as that of the peach moth, since the period of development is essentially the same as that of its host. That is to say, development from egg to adult requires approximately the same length of time as the peach moth and the only chance for this species to

[1] It has also been reared by us from Connecticut leaf rollers.

gain on its host lies in the greater egg-laying powers of the parasite.

Under normal conditions many "Macro" larvae will emerge from hibernating larvae in October, leaving few to be carried over until the following year. Those passing the winter do so in the larval stage inside the host, spinning and pupating the following spring. Development will naturally be slower in fall and spring than in midsummer, so that the life cycle as stated will not apply at these periods.

Of all larval parasites collected in nine orchards in 1929, 65 per cent were Macrocentrus, which shows the relative importance of this species. Less extensive collecting in 1928 showed relatively few. "Macros" first began to be noticed in Connecticut in the orchard of the Barnes Orchard and Nursery Company at Wallingford in 1926, when a decided reduction in fruit injury occurred. They were again noticed in 1927 and reduction in injury attributed in part to their presence together with cultivation that was thoroughly done. Further observation at Southington in 1928 and 1929, however, led to the conclusion that cultivation had not reduced the infestation materially. At East Wallingford in the Young orchard, there was a decided drop in infested fruit for the first time in 1929 and the "Macros" were collected in considerable numbers in this orchard in June. It seems logical to attribute some beneficial action to the parasites present in the orchard, and in all probability the Macrocentrus species have had much to do with it.

According to Stearns (80), as well as our own work in two different localities in 1929, the parasitism of Macrocentrus rises sharply as the number of twig-infesting larvae decreases and more peach moth larvae enter the fruit. This will account in large measure for increased percentages of parasitism in late summer and should not necessarily be taken to indicate greatly increased parasitism. We believe an early parasitism, 40 to 50 per cent, reaching its height in the second brood occurring in July, is needed to check the peach moth and that it is highly desirable to supplement its work with another parasite or parasites which will work better on larvae in the fruit or in the egg. The following table gives results of liberations of "Macros" in 1929.

Introduction of Macrocentrus

In 1929 about 1,000 "Macros" were placed in an orchard in Southington and approximately 300 in Farmington, where no parasites were observed. These came from the laboratory of the United States Bureau of Entomology, at Moorestown, N. J., in wooden boxes containing 100 to 400 adults. Others were brought back by the writer in strawberry leaf-rollers from which the para-

TABLE 27. RESULTS OF MACROCENTRUS LIBERATIONS, 1929

Source of twigs	Date of collection	Moths obtained	Macrocentrus obtained	Larvae (alive)	Per cent parasites to date	Notes
Southington, Rogers	June 10	56	1	0	1.7	General collections in vicinity of Plots 1 and 2
Rogers	July 2	11	4	0	26	General collections in vicinity of Plots 1 and 2
Rogers	July 15	37	10	0	21	General collections in vicinity of Plots 1 and 2
Rogers	Aug. 13	0	23	4	85	General collections in vicinity of Plots 1 and 2
Rogers plots 1 and 2	Aug. 24	0	6	0	100	
" plots 1 and 2	Sept. 2	1	3	3	42	Collected from trunks of trees
" plot 3	Aug. 26	1	4	0	80	
" plots 4 and 5	Sept. 2	0	3	0	100	
Southington, Rogers "Barn lot"	Aug. 13	2	40	10	77	About 2 miles from points where parasites were liberated
Farmington, Root	July 15	50	0	0	00	Collections in June also showed no parasitism
Root	Sept. 2	1	2	4	28	Collections in June also showed no parasitism

Record of Parasites Released, Southington, Rogers orchard

Plot	Date	Males	Females	Total parasites	Notes
1	Aug. 13	72	54	126	Counted by us
2	Aug. 15	88	81	169	Counted by us
3	Aug. 22	400 males and females		400	Not counted by us
4	Aug. 29	129	175	304	
				999	

Farmington, Root orchard

Date	Total parasites
Aug. 15	10
Aug. 20	112
Aug. 26	200
	322

sites were subsequently bred. Both methods were successful as far as the parasites themselves were concerned. "Macros" are easily handled, and we experienced no difficulty in getting them into orchards 25 to 40 miles from the laboratory. They can no doubt be transported with ease much further. The strawberry leaf rollers were collected in New Jersey the last week of July, brought to New Haven, where the folded leaves were kept for awhile in our insectary and then put in emergence cages. Plate X, b. Some 450 parasites emerged from a total of 6,000 folded leaves. They were placed in a small mating box after emergence and transported therein direct to the orchard. · Release of this lot was made in several different portions of the orchard, locations being selected where there were plenty of new growth and freshly-injured twigs. Recovery of the parasite was made in the Farmington orchard towards the latter part of the season. At the Southington orchard "Macros" were present in June, averaging 1 to 2 per cent in collections made June 10 and 17. In July it increased to 20 per cent and in August there was a further increase to 80 per cent which was shortly before parasite introduction. Collections after this date varied from 80 to 100 per cent parasitized.

Glypta rufiscutellaris Cresson

Plate VIII, b.

This is a second larval parasite, fairly common in some years, but decreasing to negligible numbers in others. It was observed in 1928 to constitute about 70 per cent of the parasites collected on the Station grounds in New Haven, whereas in 1929 there were no Glypta taken in this locality. Just why this variation should occur is not well understood.

Not much is known of the life history in Connecticut except that the adults appear in August and September and frequently winter in the cocoons of the peach moth. From this it would appear as if there were two generations. We have not observed mating nor have we been able to get them to oviposit in larvae that infest twigs. Glypta will no doubt prove to be useful in some orchards, but it will need to be studied carefully to determine the best methods of handling, as well as the cause of fluctuations already mentioned. We have succeeded in rearing this species also from strawberry leaf rollers obtained in Connecticut.

Trichogramma minuta Riley

Plate IX, a; Figure 34, A.

Eggs of the Oriental peach moth are parasitized by this species, the small fly inserting its eggs directly in the eggs of the peach

moth. The entire life cycle of the parasite from egg to adult is passed within the egg, which is completely destroyed. Parasitism of this type is highly desirable, especially since there is no chance on the part of the peach moth to do damage before being killed. Investigations in Connecticut have revealed the presence of Trichogramma in considerable numbers in four different orchards and it doubtless occurs in others. It was found at New Haven in 1929, parasitizing eggs placed in the trees as well as eggs normally present. Table 28 gives the results of these counts:

TABLE 28. PARASITISM OF THE ORIENTAL PEACH MOTH BY TRICHOGRAMMA MINUTA

Date	Number of eggs	Per cent of parasitism	Notes
June 21	39	20	In eggs normally present
June 22–25	89	51	Placed in the field in several different locations
June 26–28	63	49	Placed in the field in several different locations
July 5–8	39	66	Placed in the field in several different locations
July 16–18	278	20	Placed in the field in several different locations
Aug. 17–20	216	68.9	Placed in the field in several different locations
Sept. 5	192	80	Eggs normally present, collected from leaves on trees

Parasitism of this magnitude must result in some good; it should be noted that parasitism began early and continued until harvest. At Mount Carmel parasitism was not followed throughout the season, but was observed in June to be about 15 per cent and again in September, when more than 80 per cent of the eggs were affected. An attempt was made at Southington to colonize the species with material obtained from the laboratory of the United States Bureau of Entomology, at Arlington, Mass. The parasites were obtained in grain moth eggs fastened to small pasteboard cards. These were hung in trees, using about 4,000 per tree, and the degree of parasitism was determined before and after from counts of eggs placed in the trees. These data are shown in Table 29.

The data in Table 29 indicate, but not conclusively, that there was some increase in parasitism from the liberations, but they do show that Trichogramma was working effectively about August 5. The owner noticed some reduction in injury in the vicinity of the plot on early fruit, Belle of Georgia, but not in some of the later varieties, partly because of the small crop. With the amount of larval parasitism by Macrocentrus that occurred here during August and the egg parasitism, we look for a marked decrease in

TABLE 29. RESULTS OF TRICHOGRAMMA LIBERATION AT SOUTHINGTON, CONN. PARASITES HUNG ABOUT AUGUST 1

Eggs exposed July 20, 22					Eggs exposed August 5-8		
Tree No.	Total eggs	Parasitized	%		Total eggs	Parasitized	%
1	120	0		Inside test plot	18	3	
2	62	0		"	66	10	
3	159	4		"	58	1	
4	41	4		"	63	24	
5	185	21		"	201	6	
Totals	557	29	5	"	406	44	10
6	68	12		North of test plot	136	33	
7	112	0		"	103	38	
8	3	2		"			
Totals	183	14	7	"	239	71	29
9	14	0		South of test plot	11	7	
10	35	2		"	31	15	
Totals	49	2	4	"	42	22	52
Totals	770	45	5	West of test plot	93	29	-
				"	13	0	
				"	106	29	27
				East of test plot	91	32	35
				Totals	885	197	22

abundance of the peach moth in 1930, unless other unforeseen factors interfere.

Following the discovery of Mr. Flanders in 1927 (84) of the fact that *Trichogramma minuta* may be bred on grain moth eggs,[1] many entomologists have taken up the work. This has resulted in the development of a technique which enables one to grow them in large numbers. There are, however, a number of difficulties to be overcome. Mites, such as *Pediculoides ventricosus,* and species of the family Gamasidae or Parasitidae cause much trouble, the first destroying the grain moth by feeding on various stages, and the second by feeding on the eggs. Apparently the most satisfactory method of dealing with these pests is to heat the grain that is used before infesting it with grain moths. Some workers have used sulfur to keep down mites, while others report failure of this means because of the fact that sulfur destroys or repels the parasite Trichogramma. Various incubators (89) and other apparatus have been devised for rearing the moths, the incubators being intended to maintain the temperature at 80° F. or above and the humidity at 50 to 70 per cent. The main problem seems to

[1] *Sitotroga cerealella.*

be in maintaining grain moths in large enough quantities to produce enormous quantities of eggs and the development of laboratory technique sufficient to handle them efficiently and economically.

Modifications of Orchard Practices to Favor Parasites

It has been suggested that various measures be taken to favor parasites in the orchard. One of these schemes involves planting strawberries in or near the orchard in order to provide strawberry leaf roller hosts for Macrocentrus after the peach moth leaves the twigs. Another such scheme involves late stimulation of occasional peach trees throughout an orchard so that twig infestations by the peach moth may continue as long as possible, thus providing means for *Macrocentrus to carry over from season to season. Neither of* these plans has been tested commercially or scientifically, so that no definite recommendations can be made. It would also seem from our experience that the effect of various orchard spray and dusting practices as well as cultivation should be carefully studied in relation to their effect on Trichogramma egg parasites.

Attempt to Rear Parasites under Artificial Conditions

Following the discovery that parasites work fairly well in Connecticut and that they will survive our winters, the peach growers under the leadership of Mr. H. M. Rogers, of Southington, have asked that a laboratory for their production be organized. Consequently an emergency appropriation was secured, together with subscriptions from about 150 growers, amounting in all to about $7,000.00. With this fund work has been started, both with Trichogramma and Macrocentrus. It is too early to say much about this work other than that considerable progress has been made.

ACKNOWLEDGMENTS

In connection with our experiments in peach moth control, the author gratefully acknowledges the help given by various orchard owners as well as temporary assistants in our department who have helped in fruit counts and spray programs. The aid received from Mr. G. A. Drew and Mr. H. B. Reed of Conyers Farm, from the Barnes Brothers of the Barnes Orchard and Nursery Company, from the Bishop Brothers of Cheshire, and from Mr. S. H. MacDonald of Wallingford is especially acknowledged. These men have made treatments at our suggestion, have supplied spray outfits and labor or have helped in other ways. Mr. J. F. Townsend has been of great assistance in field and insectary work and his labors have resulted in much expansion of the work in 1929. His work in the construction of various appa-

ratus has been especially helpful. Mr. B. H. Walden made the photographs and deserves all credit for them. We are also greatly indebted to the Federal laboratories at Moorestown and Arlington, where we secured much valuable aid through the kindness of Dr. H. W. Allen and Mr. D. W. Jones. We are also indebted to Dr. R. C. Roark of the United States Bureau of Chemistry and Soils, who supplied a quantity of rotenone for study, and to Mr. Neely Turner for his help with various control experiments.

REFERENCES TO LITERATURE

The literature on the Oriental peach moth is rapidly becoming so voluminous that space and time make it impossible to quote all references here. So rapidly in fact is the literature on this important pest increasing that many papers cited will soon be out of date or superseded by more extensive publications. The papers quoted will, however, show the general trend of investigations, and afford the exact titles for works cited in the text of this article.

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Papers Dealing With Trichogramma Production and Life History

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Page 55. "Silicofluoride dusting does not appear to destroy the Trichogramma egg parasites, either within the borer eggs before they emerge or in their attack on freshly laid borer eggs in dusted fields."

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Trichogramma life cycle 8-50 days with 12-14 generations in the vicinity of Philadelphia.

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Page 209, "The average of 35 experiments indicates that six (6.19) times as many adults of *Trichogramma minutum* emerge in the first hour after being exposed to daylight as emerge in the dark per hour of previous daylight in the same day."

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Figures apparatus and describes it.

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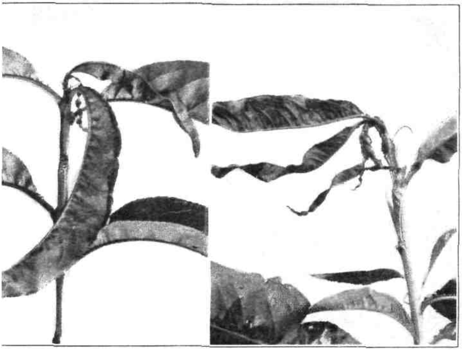
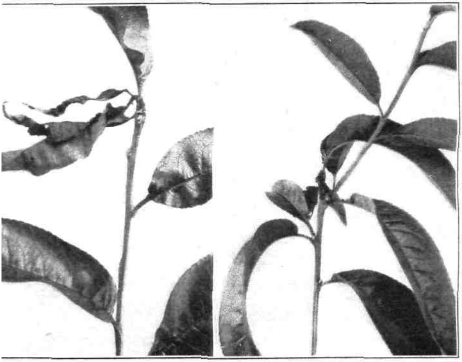
States that larvae kept at 10-11° C. (50-51.8° F.) enter a diapause and do not pupate.

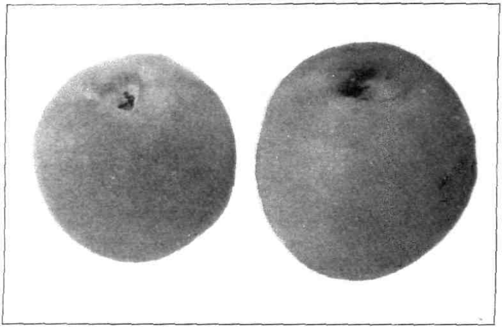


a. Newly infested twig, left; more advanced stage, right.

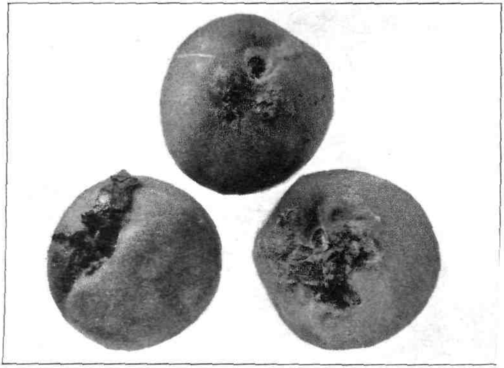


ured twig after the larva has abandoned it, left; similar twig still later showing how laterals are forced out, right.

PLATE II

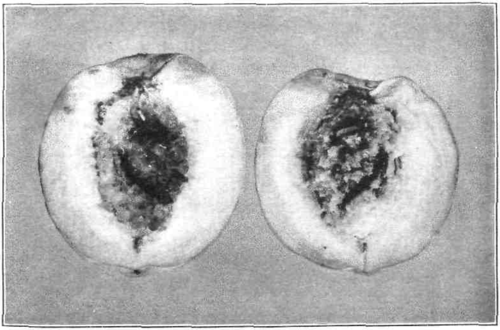


a. Ripe fruit with inconspicuous entrance marks of larvae near stems, late brood.



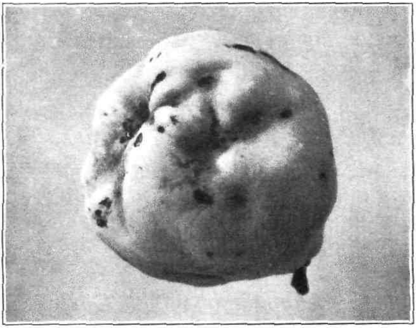
b. Exterior marks of infestation, early brood.

a. Peach with nearly full grown larva, left; exterior marks of infestation, right.

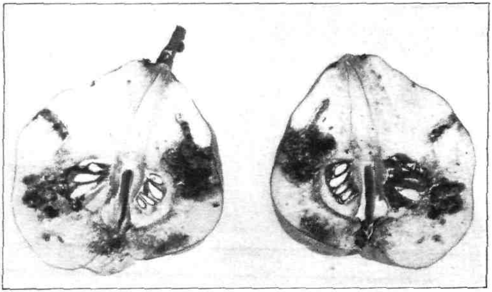


b. Ripe peach containing two larvae.

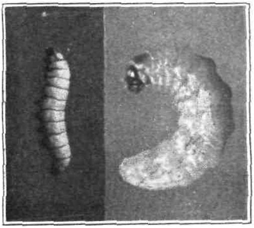
PLATE IV



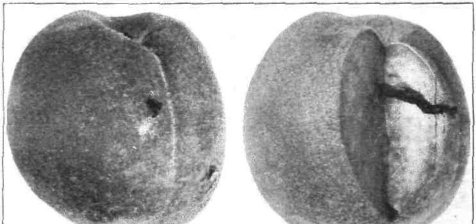
a. Mature quince infested with Oriental peach moth.



b. Quince cut open to show condition of the interior.

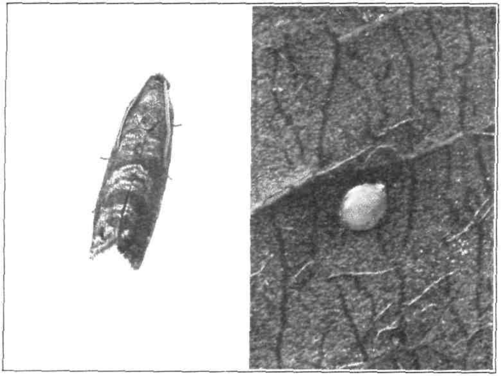


a. Larva of Oriental peach moth and plum curculio compared: left, Oriental peach moth full-grown larva; *right, full-grown curculio larva.* Both considerably enlarged.

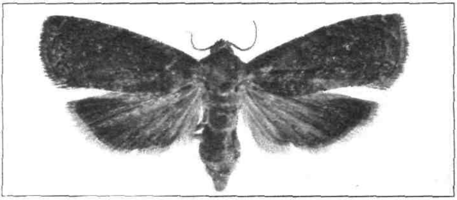


b. Infested peach showing exit hole of larva.

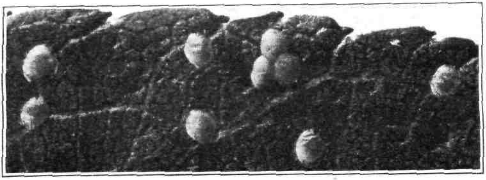
PLATE VI



a. Left, adult moth, enlarged six times; right, egg, enlarged eighteen times.

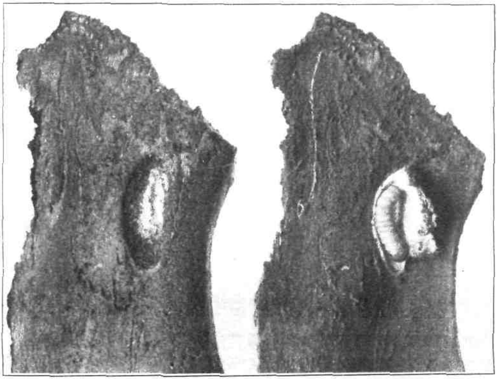


b. Adult female moth enlarged six times.



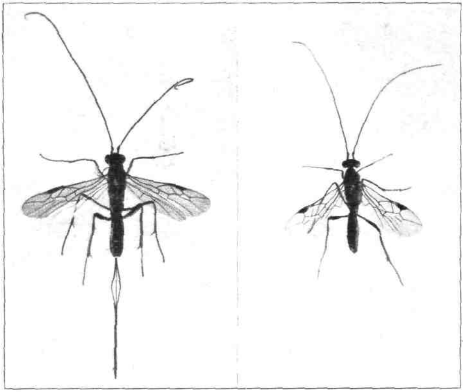
c. Eggs on surface of peach leaf obtained in insectary cage, enlarged ten times.

a. Pupa in cocoon enlarged four times, left; protruding pupal skin from which adult has emerged, right; enlarged ten times.

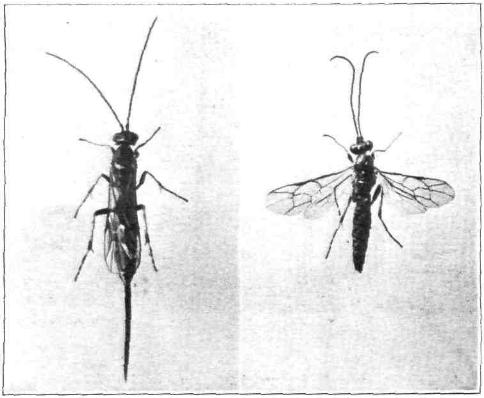


b. Left, cocoon under bark; right, cocoon opened to show insect. Twice enlarged.

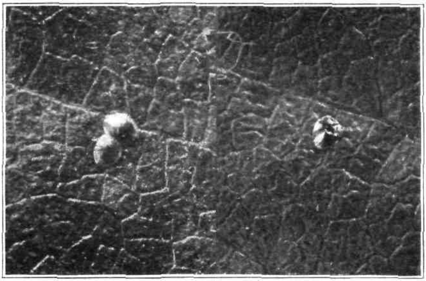
PLATE VIII



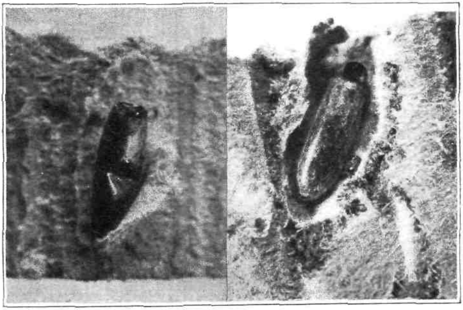
a. *Macrocentrus ancylivora* Rohwer, female, left; male, right.
Enlarged four times.



b. *Glypta rufiscutellaris* Cresson, female, left; male, right.
Enlarged four times.

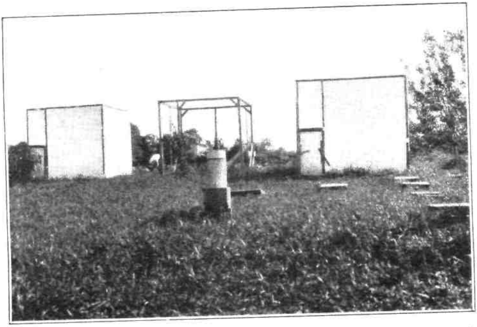


a. Eggs parasitized by Trichogramma, left; egg from which parasite has emerged, right.

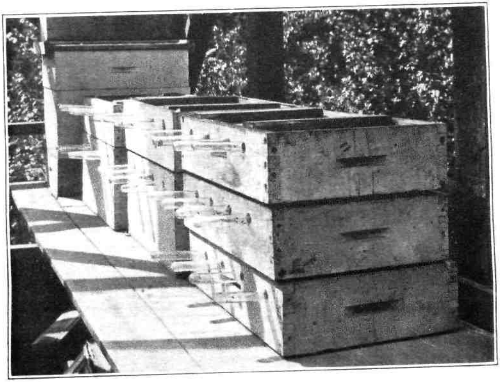


b. Cocoons of *Macrocentrus ancylivora* Rohwer.

PLATE X

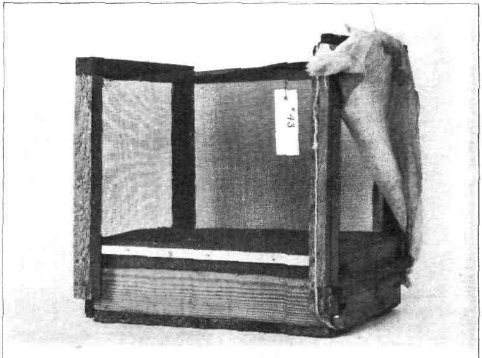


a. Tree cages at Mount Carmel farm used in studying the Oriental peach moth.



b. Trays used for emergence of *Macrocentrus ancylivora* in 1929.

a. Drop fruits in a heavily infested orchard. Many more than this are sometimes seen.



b. Cage used for obtaining eggs of the Oriental peach moth. This cage is so constructed that no smooth surface is presented to the moths for oviposition. Peach shoots are placed within and moist sand in the bottom tray. Constructed by Mr. J. F. Townsend, slightly modified from a cage in use by the Federal Government at Moorestown, N. J.

a. Outfit used in spraying peach trees, Conyers farm, Greenwich.

b. Dusting outfit used at Conyers farm, Greenwich.

Bulletin 314 April, 1930

WHITE PINE BLISTER RUST CONTROL IN CONNECTICUT

J. E. RILEY, JR.

In Cooperation with Bureau of Plant Industry
United States Department of Agriculture

Connecticut
Agricultural Experiment Station
New Haven

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THE TUTTLE, MOREHOUSE & TAYLOR COMPANY, NEW HAVEN, CONN.

HOW TO PREVENT BLISTER RUST DAMAGE TO WHITE PINE

White pine, Connecticut's most valuable forest tree, is seriously threatened by the white pine blister rust. The greatest single factor at the present time in the control of the blister rust is the elimination of the European black currant. The growing, sale or possession of this plant is prohibited by law in the State of Connecticut. Help control the blister rust by destroying all European black currants wherever found.

1. Uproot all currant and gooseberry plants throughout the white pine and for a surrounding distance of 900 feet.

2. Pull the bushes. Do not cut them off at the ground. Grub out the root crown and main roots in order to prevent sprouting and hang the bushes so as to prevent the roots coming in contact with the ground.

3. Make sure that there are no European black currants within one mile of the pine stand. Notify the Connecticut Agricultural Experiment Station in case the owners do not destroy them.

4. For free advice and inspection write to the Station Forester, Connecticut Agricultural Experiment Station, Box 1106, New Haven, Conn.

CONTENTS

	Page
Introduction	455
Importance of white pine	455
History	456
Nature of the rust	457
Life cycle	457
Control measures	459
How to recognize the blister rust	461
Blister rust control in Connecticut	463
Authority	463
Organization	463
Individual coöperation	464
Nursery sanitation	464
Black currant eradication	466
Present status of control work	466
Effectiveness of Ribes eradication	468
Blister rust damage	468
Future control policy	470
Appendix	471
Insects and diseases commonly mistaken for blister rust	471
Common currants and gooseberries in Connecticut	472
Where to plant white pine	477

The bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

WHITE PINE BLISTER RUST CONTROL IN CONNECTICUT

J. E. Riley, Jr.

INTRODUCTION

Many pine owners are misinformed as to the nature of the white pine blister rust. This bulletin seeks to explain the life history of the disease, to discuss the need for its control and to show the status of control work in the state. It offers some suggestions that the pine owner may adapt to his problem of protection.

Importance of White Pine

Connecticut has no more valuable tree than the white pine and its protection and perpetuation is of prime importance to a sound forest program. Throughout most of the state it is one of the trees most suitable for reforestation and everywhere it is a tree to be encouraged in natural stands. It should not be used in pure plantings unless the owner is prepared to protect it from the weevil and it should not be planted at all unless it is protected from the blister rust through the elimination of currant and gooseberry plants, as described elsewhere in this bulletin. There has been a good deal of misconception concerning the practicability of growing white pine because of these two enemies but, given proper protection, it can be safely raised and will yield net returns as high, if not higher, than any other timber species in Connecticut. Frothingham in his bulletin "White Pine Under Forest Management," Bulletin 13 of the United States Department of Agriculture, says, "Of all the trees of eastern North America, white pine best combines the qualities of utility, rapid growth, heavy yield and ease of management." No other tree offers such a combination of advantages.

The wood of the white pine is light in weight, soft, and evenly textured. It takes a pleasing finish and has very little tendency to warp. Its durability is demonstrated in the many century-old

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Author's Acknowledgments. The author wishes to express his appreciation for the constructive criticism of the manuscript by Roy G. Pierce of the office of Blister Rust Control, United States Bureau of Plant Industry, and of others in the Department of Agriculture. The photographs used in the text of the publication were made by the federal office of Blister Rust Control, except those from the New York Conservation Department and the New York Agricultural Experiment Station, Geneva, which were obtained through the federal office.

houses now standing throughout New England sheathed with the original white pine lumber.

The two most serious enemies of the white pine in this region are the white pine weevil, *Pissodes strobi,* described in the appendix, and the white pine blister rust, *Cronartium ribicola* Fisch. The white pine blister rust is a plant parasite that threatens not only serious damage to the present crop, but like the chestnut blight on the chestnut, it may, if not controlled, destroy the commercial value of the species. Fortunately, this disease, although it cannot be entirely eradicated, can be and is being controlled in Connecticut, as it is in the other white pine growing states. Before discussing the work of blister rust control, let us first consider the history of the blister rust, its nature and how it acts.

HISTORY

The blister rust is not of recent origin, although it is comparatively new to this country. In 1854, Dietrich, a German botanist, reported it in northwestern Russia on pine and Ribes as two distinct fungi. The relationship of the previously supposed separate fungi was shown by Klebahn of Germany in 1888. It has been known in Europe, England, Scotland, Siberia and Japan for many years. Spaulding, in Bulletin 206, United States Department of Agriculture, states that losses as high as 100 percent have been reported in Europe. Moir (Bulletin 6, American Plant Pest Committee) reports that in Norway, Sweden, Denmark and Belgium the use of white pine in the regeneration of forests has been practically discontinued because of the rust. There the American white pine is an exotic tree and the native five-needled species are of comparatively little importance, whereas currants and gooseberries, especially the European black currant, constitute a highly valued food crop.

The rust is now known to have existed in this country at Kittery Point, Maine, since 1898, having in all probability been imported on English black currants planted there about that time. It was found at Geneva, N. Y., on Ribes in 1906. Reliable evidence points to the fact that it had been discovered on nursery white pine at Philadelphia in 1905.[1] It is supposed to have existed in Pomfret, Conn., on imported white pine since 1902. Several of the eastern states had been for a few years previous to 1909 importing white pine stock from Europe and not until after the trees had been planted out was it discovered that they were diseased. In Connecticut, C. A. Metzgar first found it in the

[1] Phytopathology, 7: No. 3, 224-225, June, 1917, R. G. Pierce. Also published in Bull. 239 of Pennsylvania State College, School of Agriculture and Experiment Station, entitled "The Rusts of Pennsylvania," by Kern and other authors, May, 1929.

spring of 1909 on some imported white pine stock that he was planting in Wilton. He sent specimens to the Connecticut Agricultural Experiment Station, where the infection was identified as the white pine blister rust.

When the disease was first discovered in Connecticut it was hoped that by prompt destruction of all diseased pine the rust could be eradicated. However, by 1915 it was found that the disease was present on wild Ribes and in 1916 a state wide inspection in coöperation with the United States Department of Agriculture convinced the authorities that the rust was permanently established and that protection to pine through the elimination of Ribes was the only practical control. Since that time the natural pine areas of the state have been examined for the presence of wild currant and gooseberry plants and many thousands have been uprooted and destroyed.

The white pine blister rust is now found in New England, New York, Pennsylvania, New Jersey, Michigan, Minnesota, Wisconsin, Washington, Oregon, Idaho and Montana and will eventually be established throughout the natural range of the white pines in this country. In Canada it is found in the provinces of Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island and British Columbia.

NATURE OF THE RUST

Blister rust is caused by a parasitic fungus known as *Cronartium ribicola* Fisch. It is neither insect nor worm, as is sometimes supposed, but a low form of plant life that lives alternately on the white or five-needle pines and on the leaves of all species of currant and gooseberry plants. In the white pine it grows in the bark and kills the tree by girdling. Death occurs from three to twenty years after infection takes place, depending upon the size of the infected tree and number and location of the cankers. The fungus reproduces itself by means of seed bodies called spores.

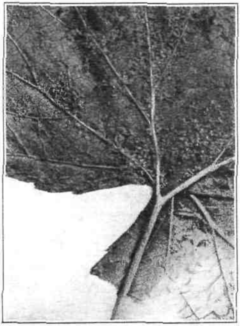
LIFE CYCLE

The spores enter the tree through the breathing pores of the needles. The spores germinate, sending a thread-like growth, invisible to the naked eye, into the tissue of the needles. From there the fungus grows downward into the twigs, branches and trunk, eventually girdling the tree. Its presence can usually be detected after it has been in the tree two years or more, by swellings of the bark called cankers. These are characterized by an orange-yellow or a yellow-green discoloration at their advancing edge and, in one stage, by small blood-clot colored areas known as pycnial spots, which contain a sweet-tasting liquid, the function

a

b

c



d

FIGURE 35. *a*, Fruiting stage of blister rust on young white pine; *b*. Fruiting canker on trunk of older tree (note that the bark in the center of the fruiting canker has been eaten by rodents); *c*, First summer stage of blister rust on flowering currant; *d*, Second summer stage of blister rust on European black currant leaf (the stage that produces spores, which infest pine).

NOTE—Plates *a* and *d* are presented by courtesy of N. Y. Cons. Dept.; *c* by courtesy of N. Y. Exp. Sta., Geneva.

of which is unknown. When the disease has been in the tree three years or more the bark on the cankered area cracks open, exposing orange-yellow blisters. These blisters are another positive identification of the rust. They appear in the early spring and are in evidence for several weeks. When they break, the orange-yellow powder within, composed of millions of spore bodies, is spread by the winds.

If these spores come in contact with the under side of currant or gooseberry leaves and the moisture conditions are right, many spores germinate and grow into the leaf, thus causing the first summer stage of the rust on these plants. In two or three weeks rust-colored spots appear on the under side of the infected leaf. These spots contain the summer spores, which spread the rust locally on currants and gooseberries. From late June until the leaves drop in the fall, brownish, hair-like growths replace the rust-colored spots in increasing numbers. These outgrowths produce the fall spores, which infect pine and thus complete the life cycle.

CONTROL MEASURES

There are several interesting facts in connection with this life cycle, a knowledge of which makes possible practical control measures. They are—

1. The *spring spores from pines cannot infect other pines.* They infect the leaves of currants and gooseberries only. This infection may occur over long distances.

2. The summer spores from currants and gooseberries likewise cannot infect pines. They simply intensify the disease locally on currants and gooseberries.

3. The fall spores from currants and gooseberries spread the disease to white pines. The infecting range of these spores is short, ordinarily not more than 900 feet.

4. The cultivated English black currant will take infection from white pine over a distance of one hundred miles or more, and will transmit it to pines a mile away. The English black currants, therefore, act as infection centers and constitute an especially grave menace to white pines.

All true currants and gooseberries, both wild and cultivated, belong to the genus Ribes and hereafter in this bulletin the generic name Ribes will be used in place of currants and gooseberries. Control measures may be briefly stated as—

1. The elimination of Ribes throughout pine areas and for a surrounding distance of 900 feet.

2. The destruction of all English black currant plants, *Ribes nigrum,* within a mile of the pine stands.

Such control work can be effectively carried on by pine owners, but experience has shown that more effective and thorough initial work is obtained by a state-supervised crew under trained leader-

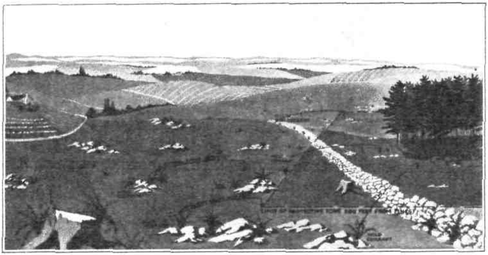


FIGURE 36. This stand of pine is afforded practical protection from the blister rust because there are no currants or gooseberries within 900 feet of the stand and no European black currants within one mile.

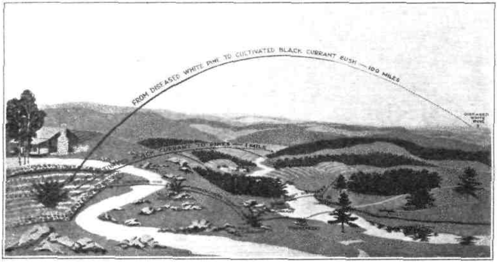


FIGURE 37. The European black currant will take infection over a distance of *100 miles from diseased white pine. This bush may be responsible* for transmitting the disease to pines a mile away.

ship. Crew men employed on job after job, and often year after year, learn to know the various currants and gooseberries in their association with other vegetation and consequently become expert in locating them. Also from a knowledge of Ribes growth and

location gained through experience, trained scouts are able to protect many pine areas where Ribes are few with a minimum of effort and expense.

On the other hand there are certain advantages to the pine owner if he himself eradicates the wild Ribes on his land. He learns to identify the various species of Ribes and their habits and is therefore in a better position to keep his pine areas free from these plants, than if others did the work for him. His personal participation in the work results in a keener appreciation of the situation and a more intelligent interest in pine protection. For the information of those who wish personally to carry on the control work and are interested in identifying the species found, a description of the currants and gooseberries commonly found in Connecticut will be included in the appendix.

HOW TO RECOGNIZE THE BLISTER RUST

There are several signs by which the blister rust may be positively identified in the field and others by which the presence of the rust in a tree may be indicated from a distance. One or more of these indications or signs will always be in evidence after the disease has been in the tree two years or more.

"Flags." This term is applied to the discolored foliage of a branch or portion of a tree infected with the rust. When the fungus has been in the tree long enough to cause partial or total girdling of the infected part, the needles often take on a sickly yellow color peculiar to rust-infected trees. These "flags" may, however, vary from slightly "off-color" needles to the red-brown color of dead leaves. Such flags are not positive identification of the rust, but serve to call attention to a tree that is abnormal. Closer inspection reveals other signs.

Cankers. When the rust has been in the tree two years or more a swelling occurs on the bark of the infected twig or limb. This swelling is called a canker. The canker bears certain signs that positively identify the white pine blister rust. Around the advancing edges may usually be seen an area of yellow-green to orange-yellow discoloration. This discoloration becomes more apparent when the canker is wet and it positively identifies the rust.

Pycnial spots. The year previous to the appearance of the blisters, or fruiting bodies, small blood-clot colored areas form on the bark of the canker. The color varies from a reddish brown to almost black. Within these spots is a sweet tasting liquid, which oozes out in clear drops. These pycnial spots are another positive identification of the rust. Very often when the pycnial spot disappears, it leaves a characteristic scar.

Blisters. Three years or more after infection takes place and a year after the pycnial spots appear, the bark at the canker cracks

open and exposes bean-shaped blisters that are yellow in appearance, but in reality are composed of a white or colorless membrane within which is an orange-yellow powder composed of millions of seed bodies, or spores. These blisters appear in the early summer and last only a few weeks, when they break, liberating the spores, which are disseminated by the wind and leave the membrane clinging to the blister pits. These blisters are unmistakable evidence of the rust.

Old cankers. Old cankers are characterized by cracked bark, more or less evidence of blister pits, often constricted areas below the canker and swollen areas above the canker. If the branch or trunk containing the canker is not dead, the typical yellow-green or orange-yellow discoloration at the advancing edge of the canker may be in evidence. An exudation of pitch is often found on or below the older cankers. On dead cankers the discoloration, pycnial spots or blister pits may not show because of the deteriorated condition of the bark.

Rodent work. Field mice, squirrels and other rodents apparently like the blister rust infected bark. Often this bark is eaten to the bare wood. Such rodent work rarely occurs on white pine bark uninfected by the rust.

Sometimes these signs are partially obliterated by the presence of secondary fungi that gain entrance in the tree already weakened by the rust, but one or more of the above described signs will practically always be in evidence. Doubtful specimens may be sent to the Connecticut Agricultural Experiment Station for identification.

Blister rust on Ribes. Fruiting bodies on infected Ribes appear in early June on the under side of the leaf. They are rust-colored spots, a few in number at first, but as the season progresses they become more numerous, until sometimes they nearly cover the under surface of the leaf. The only other disease that they are likely to be confused with is the cluster cup fungus, but the difference is easily seen under an ordinary magnifying glass. The yellow cluster cup fungus spot, appearing on the upper as well as the lower surface of the leaf, is circular in shape and is composed of a group of perfectly circular cup-shaped depressions imbedded in the tissue of the leaf, usually toothed at the edge. The white pine blister rust is a rust-colored spot, irregular in shape, that appears only on the under surface, although there may be a dead area on the upper surface above the fruiting bodies.

Another kind of fruiting body of the blister rust appears on the under side of the leaf in late June and continues to increase in numbers until the leaves drop in the fall. These are brown hair-like growths about one-quarter inch in length, which take on a grey color in wet weather. They are the fruiting bodies that have been previously mentioned as producing the spores that carry the disease to the white pines.

Several tree diseases and insect pests are commonly mistaken for the white pine blister rust, but confusion may be easily avoided by a moment's close observation. In the appendix of this bulletin the few tree pests most often mistaken for the rust are briefly described and the means of distinguishing them from the blister rust are pointed out.

BLISTER RUST CONTROL IN CONNECTICUT

Authority

Authority for the control of the white pine blister rust is found in Sections 2106 and 2117 of the General Statutes of 1918. These have been briefly summarized by Filley and Hicock in Bulletin 237, as follows—

1. *A general plant pest law authorizing the Director of the* Connecticut Agricultural Experiment Station to control insects or diseases which are, or may become, serious pests to economic plants. He is given the power to destroy infected plants, prohibit or regulate the transportation of the same and to establish quarantine in such areas and against such pests as he may deem necessary. (G. S. 1918, Sec. 2106.)

2. A blister rust law authorizing the Director of the Connecticut Agricultural Experiment Station to control the white pine blister rust. He is given the power to order white pines uprooted and to destroy all wild currant and gooseberry plants and those under cultivation if infected. (G. S. 1918, Sec. 2117.)

In the past it has not been necessary to take drastic measures to enforce these laws. The blister rust control work has been conducted on a basis of coöperation, and the Station has enjoyed a gratifying support in its program of control from individuals and towns and from associations of pine owners.

On July 1, 1929, a European black currant law became effective, whereby the possession of the English black currant is prohibited. Chapter 172 of the Public Acts of 1929 reads:

SECTION 1. Any person who shall grow, plant, propagate, cultivate, sell, transport or possess any plant, root or cutting of the *European* black *currant, or Ribes nigrum, shall* be *fined not less* than five dollars nor more than twenty-five dollars.

SEC. 2. The Director of the Connecticut Agricultural Experiment Station is authorized to seize and destroy any plants, roots or cuttings of said European black currant found in the state.

Organization

The blister rust control work in Connecticut is conducted under a coöperative agreement between the United States Department of Agriculture and the Connecticut Agricultural Experiment Station.

The Station Forester, designated as Federal Collaborator, is the administrative head of the organization and he obtains his regulatory authority from the Director of the Station, who is charged by law with control of plant pests. Assisting the Station Forester is a State Leader, who exercises general supervision over the field work. One or more federal agents are employed on educational work, gathering data and organizing local coöperation. Several state scouts and crews, the latter working under the direction of experienced state foremen, carry on the eradication of Ribes under the immediate supervision of the agents.

Since 1922 the coöperative agreement between the United States Department of Agriculture and the Connecticut Agricultural Experiment Station specifies in effect that federal funds shall be used for education, experimentation, collection of data and supervision only, and not for actual eradication of currant and gooseberries. State funds are used for collection of data, direction of eradication crews, and some crew labor.

Individual Coöperation

In the early years of the control work, when it was hoped that the disease could be eradicated, no attempt was made to enlist the coöperation of the pine owner. As it became apparent that blister rust was here to stay and that pine protection had become a matter of local control, the coöperation of individual pine owners, associations of pine owners and towns was sought on the grounds that blister rust control was as much an individual and local problem as a state responsibility. Part of the financial burden of control is being gradually shifted from the state to the individual, although it is recognized that the state must continue to keep in touch with the situation through systematic inspections of pine areas, and that it must guide and supervise the control work.

A re-eradication problem will always exist, although the amount of re-eradication should diminish from year to year as control work diminishes the number of Ribes, and as the closing in of the pine canopy so shades the ground as to prevent Ribes reproduction. There is still a need for a good deal of research, particularly along lines of control methods, Ribes regrowth and improved forest practice. This is a function that can be best performed by the federal and state agencies who have the personnel and facilities for carrying on such work and for making the results available to pine owners.

Nursery Sanitation

Of utmost importance to the success of the control work is the insurance of disease-free stock for reforestation and ornamental plantings. The interstate movement of white pines and of currant

and gooseberry plants is prohibited by federal quarantine No. 63, except under strict compliance with its very stringent provisions. Distribution of Connecticut grown stock is legally possible within the state only under permit from the state nursery inspector.

Stock showing a serious disease, such as the blister rust, is destroyed. This inspection, however, does not in itself guarantee that the Connecticut grown white pine stock is free from the rust when shipped, because it is impossible in many cases to recognize the disease by field inspection until the rust has been in the tree two or more years. Therefore, the only assurance to the purchaser of such white pine stock that it is free from the rust is when it has been grown under Ribes-free conditions. Federal quarantine No. 63, applying only to interstate shipments, provides among other

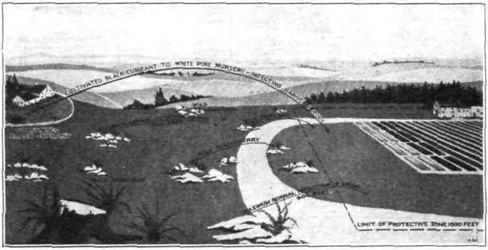


FIGURE 38. The white pine in this nursery is given complete protection because no currants or gooseberries are within 1500 feet and there are no European black currants within one mile.

regulations that all stock certified for interstate shipment shall be grown from seed in an approved control area. This control area, extending 1,500 feet around the white pine growing block, must be free from all wild and cultivated currant and gooseberry bushes and in addition there must be no European black currant plants within one mile of the pine block.

In order to give the same protection to the Connecticut grown white pine stock distributed within the state, such control areas should be established around all Connecticut white pine growing nurseries. This matter of nursery sanitation has brought a commendable response from the Connecticut nurseries growing white pine. There are now ten nurseries establishing such sanitation zones in coöperation with the Connecticut Agricultural Experiment Station, and as the advantages of such sanitation become recognized

it is likely that the number of white pine growing nurseries maintaining control areas will increase. Those now coöperating are:

Barnes Brothers Nursery Co.	Yalesville
Bristol Nurseries, Inc.	Bristol
Elm City Nursery Co.	Woodmont
North-Eastern Forestry Co.	Cheshire
Outpost Nurseries	Ridgefield
A. N. Pierson, Inc.	Cromwell
C. H. Sierman	West Hartford
Southport Nursery	Southport
Verkades Nurseries	Waterford
H. J. Zack Co.	Deep River

Black Currant Eradication

The greatest single hazard to the white pine in Connecticut at the present time is the presence of the European black currant throughout the state. It is so susceptible to the disease, it will take infection from so great a distance and will transmit it to pine so far, that control work in Connecticut will not be on a satisfactory basis until this species of Ribes has been entirely eliminated. As previously stated, the legislature has prohibited the growing, sale, transportation or possession of all roots, cuttings and plants of this species. States adjoining Connecticut have also banned it, either through legislative action or by proclamation from properly constituted authority.

PRESENT STATUS OF CONTROL WORK

On the accompanying map the cross-hatched areas indicate those towns where the needed initial eradication of Ribes is completed. The remaining towns within the natural white pine area of the state are scheduled for working in 1930. The natural white pine area of Connecticut lies north of the heavy black line; the area of abundant wild Ribes lies north of the dotted line. These latter two are more or less arbitrary divisions based upon a pine survey of 1919-1921 and reported in Bulletin 237.

During the past eleven years, 1919-1929 inclusive, approximately 219,000 acres of pine land have been freed from wild Ribes and 22,700 acres of this has been re-eradicated. More than 1,700,000 wild currant and gooseberry bushes have been destroyed and approximately 17,300 cultivated currants and gooseberries have been removed. Undoubtedly much work has been done by individuals on their own land, of which no record has been made. The cost of this work varies greatly with varying local conditions, type of labor employed and favorable or unfavorable seasons. The chief factors in the eradication costs, however, are the kind, size and number of Ribes encountered, denseness of undergrowth and,

occasionally, topographic difficulties. In the early years of eradication, when the work was almost entirely in areas of heavy Ribes concentrations, a season's work averaged 75 cents to 93 cents per acre; later when the eradication work was done on areas of lighter Ribes concentrations, the average cost for the season was from 11 cents to 56 cents per acre. The increased efficiency gained through experience is also a contributing factor to the lower costs in the later years. The average per acre cost over the eleven years period is 31 cents and the average number of Ribes per acre destroyed is 7.77.

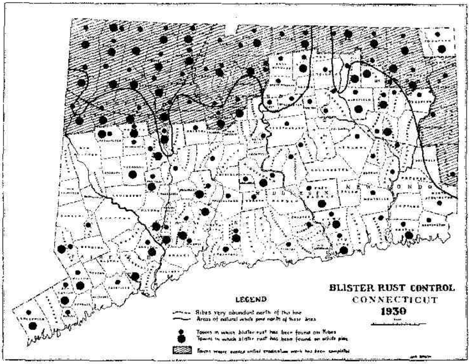


FIGURE 39. Map of Connecticut showing present status of blister rust control work.

It must be borne in mind that the costs per acre mentioned represent averages for all eradication work done during the years specified. They include areas thoroughly and systematically covered in crew eradication and areas eradicated by scouts alone. This latter type of eradication, which will not be described here, can be done often at a fraction of the cost of crew work. Pine owners eradicating Ribes on their own land, however, should use the crew method only, and the cost of such work, at prevailing day labor wages, will probably be a dollar or more per acre covered. The reason why pine owners are urged not to use the scouting method is that experience has shown that only trained and experienced men can secure satisfactory eradication of Ribes under most conditions by the scouting method.

EFFECTIVENESS OF RIBES ERADICATION

In order to determine the effectiveness of Ribes eradication in preventing or reducing blister rust infection, a number of studies have been made throughout New England and New York where eradication work is being carried on. They invariably show that where good eradication work was done, the amount of subsequent infection has been reduced to a point that does not jeopardize the productiveness of the stand. *It is not necessary to obtain 100 percent eradication of Ribes in order to secure effective control of the disease.* In fact, in many areas 100 percent eradication of Ribes can be secured only at a prohibitive cost. There are often large numbers of seedling Ribes hidden by other vegetation in proximity to older Ribes, or in locations favorable to the accumulation and germination of seed that are of such small size and so shaded by associated vegetation that they do not expose enough leaf surface to be a serious factor in the spread of the disease. Studies have shown that a large majority of such seedlings are killed off when they are small. This statement, however, should not be taken as justifying careless eradication. It is only by systematic and careful work that the currant and gooseberry leaf surface can be reduced to a point assuring practical control of the disease.

BLISTER RUST DAMAGE

No attempt has been made to determine the total damage that blister rust has already caused to white pine in Connecticut and other white pine growing states. It would be a difficult and expensive survey and its value would not justify the expense involved. The determination of the total financial losses already resulting from the rust would not help materially in future control. There is plenty of evidence, however, that shows what blister rust will do when it is once established and lives unchecked over a number of years in pine stands where Ribes are near.

Blister rust is an insidious disease and its real significance is not apparent to the casual observer. On many acres in Litchfield County white pine reproduction is being killed as fast as it appears. In numerous small areas of Connecticut infection on older trees runs 25 percent to 60 percent of the stand and many trees are already dead. Young trees are particularly susceptible to blister rust infection; they are quickly killed and within a few years all evidence that they were once on the ground is gone. This constitutes the most serious aspect of the blister rust menace and it is the one least likely to be observed.

Initial eradication and some re-eradication of Ribes has been accomplished throughout a large part of the white pine areas in the northeastern states. How much damage would have resulted

had not this work been done is unknown, but there is every reason to believe that it would have been large. Studies made throughout the northeastern states in a great many areas where the rust has

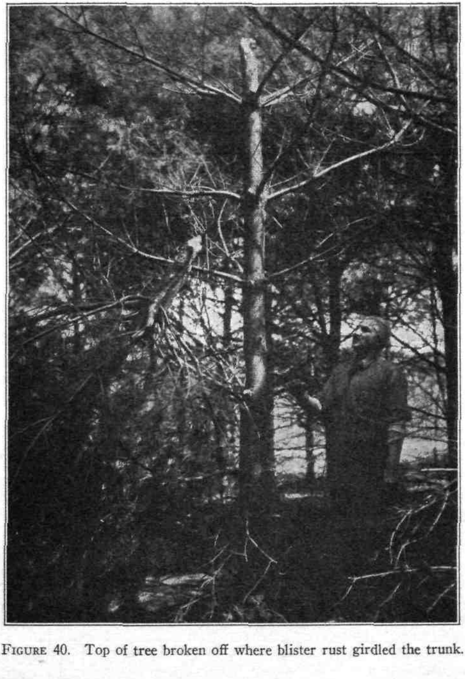


FIGURE 40. Top of tree broken off where blister rust girdled the trunk.

gone unchecked for a number of years show a high percent of infection. On numerous plots studied the infection occurring over periods of 5 to 15 years runs from 50 percent to 95 percent of the total number of trees on the plots.

Although blister rust is responsible for the death of a large percentage of the trees on many small areas in Connecticut it has to date caused comparatively small loss throughout the pine sections as a whole. This relatively light loss to pine in sections where Ribes are numerous is due to the application of control measures generally throughout the pine areas.

FUTURE CONTROL POLICY

The Connecticut Agricultural Experiment Station will continue to take advantage of the coöperation of the United States Department of Agriculture while such coöperation is available. The Station will maintain a small state organization to complete needed initial eradication of Ribes in pine areas, to organize and supervise the re-eradication work, to eliminate the European black currant throughout the state and to further nursery sanitation. It will keep abreast of the developments in control work and make such knowledge available to the pine owners. It will continue to be the policy of the Station to make inspections when requested and to give advice and assistance as far as limited personnel and funds permit.

It is impossible to make satisfactory progress on these projects without the moral and financial coöperation of the pine and Ribes owners, nurseries and others directly affected by the blister rust situation. It will be the task of the Station to acquaint the public with the high value of white pine and of the danger from the blister rust, and to stimulate control work through personal contact and publications.

The Station will scout pine areas from time to time in order to ascertain Ribes and pine infection conditions and, as far as funds permit, it will inform pine owners when re-eradication of Ribes is needed and organize and supervise control work when conditions warrant.

APPENDIX

Insects and Diseases Commonly Mistaken for Blister Rust on White Pine

Under this heading it is proposed to discuss the insects and diseases most often mistaken for the blister rust, but only to the extent of identifying them and differentiating them from the rust. Additional information on the nature, economic importance and control of the insects may be obtained from the Entomology Department of the Connecticut Agricultural Experiment Station, and information regarding the tree diseases may be had by consulting the Botany Department. Material from the Station publications is freely used here.

White Pine Tip Weevil. This is one of the two serious pests of white pine in Connecticut. The white pine weevil is a small brown snout-beetle that feeds upon the bark of the leading shoot of the white pine for a few days in early May. The female then punctures the bark and deposits its eggs, which develop minute white grubs that feed upon the inner bark for a short while and then usually burrow downward into the pith. These grubs become fully grown in less than two months and then excavate cells within which they pupate for ten days or so. They emerge as adult beetles during July and part of September.

The first indications that the weevil is present in the leader are small, clear drops of pitch, which ooze out of the punctures in the bark made by the adult beetle in depositing her eggs. The pitch dries on the stem in whitish spots and sometimes runs down the stem. Along in July the tip of the affected leader curls over and gradually turns brown. Further evidence of the weevil may be seen by splitting the affected stem, which reveals the grub tunnels, the white grubs, the pupal cells, or the beetles ready to emerge, depending upon the time of year the inspection is made. The curling of the leading shoot or affected top side shoot, the pitch drops on the stem, the circular holes from which the beetle emerges or such evidence within the twig as has been described, all identify the weevil or its work. A moment's observation with these points in mind will differentiate it from the blister rust.

The Pine Bark Aphids. The pine bark aphids are small sucking insects that cover themselves with a white cottony substance and are often found at the base of the needles, on the twigs and in patches covering large areas on the trunks of the trees. They have a complicated life history that need not be discussed here. They bear no resemblance to blister rust damage, unless it is to the pitch streaks that often occur on the older blister rust cankers; yet they are sometimes reported as blister rust by those who simply observe something unusual on the tree.

Ant Damage. A less common injury to white pine but one easily mistaken for the blister rust is the work of the mound building ants. Occasionally some or all the young pines for a radius of 15 or 20 feet surrounding the ant mound are dead or dying from ant injury. Such damage rarely occurs except in open stands where plenty of sunlight reaches the floor, because the mounds are not built in shaded areas. In order to prevent the shading of the mounds, the ants inject a substance into the bark that kills the bark cells and thus girdles the tree. The result is often a constricted area at the affected part with a swollen area above, which in this respect resembles the blister rust cankered areas. In case of ant damage, however, there are no orange-yellow or yellow-green discoloration at the outer edge of the affected bark, no pycnial spots and no blisters or blister pits. Moreover, the ant mound will be found close to the injured trees.

Needle Blight. The so-called needle blight is usually a physiological condition of the tree due to one of several causes, such as (1) late frosts, (2) sun scald, (3) winter injury of the sap conducting tissue, (4) a drying of the needles due to a sudden thaw in late winter or early spring that starts excessive transpiration from the needles when the roots cannot replenish the lost moisture because of the frozen condition of the ground, or (5) unusually dry summers. Such injury is sometimes restricted to one side of the tree. It is often identified only by eliminating other possibilities and correlating the injury with known climatic conditions. It can be easily distinguished from blister rust damage by the absence of cankers with their identifying signs previously described. The only resemblance to blister rust damage is in the partially dead needles.

Nectria-Like Fungus. A branch disease of white pine very likely to be mistaken for blister rust cankers is caused by a Nectria-like fungus that produces a roughening of the branch, and is sometimes accompanied by a slight swelling. It may be readily distinguished from the blister rust because it lacks the peculiar discoloration at the advancing edge of the canker; there are no pycnial spots, blisters or blister pits. Instead, there are small reddish fruiting bodies, about the size of a pin head, on the cracked bark.

Common Currants and Gooseberries in Connecticut

The wild currants and gooseberries are difficult to distinguish specifically, although they may be readily identified as belonging to the group of plants botanically known as Ribes. Since all native wild Ribes are susceptible to the blister rust and will transmit it to pine they may all be grouped in the same rough category as to the desirability of eradication. The cultivated Ribes, with

the exception of the European black currant, *Ribes nigrum,* may also be thus classified. The latter, however, because of its high susceptibility and because it transmits the rust to pine for long

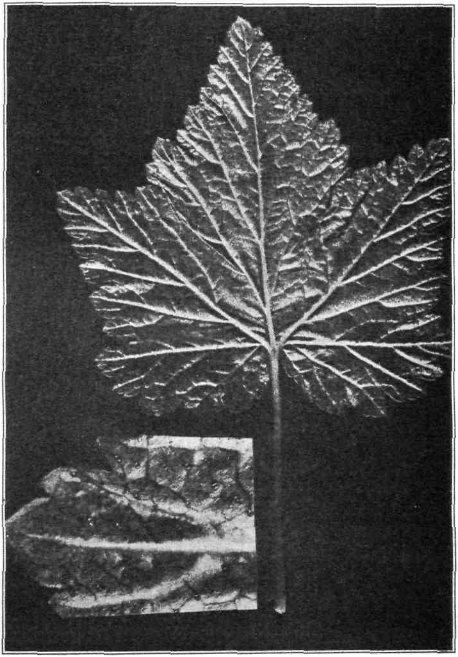


FIGURE 41. European black currant, *Ribes nigrum.* Insert shows the resin dots on the under side of the leaf.

distances, should be distinguished from the others. It calls for special consideration in the work of controlling the white pine blister rust.

In describing the Ribes of Connecticut the use of botanical terms has been avoided and an attempt has been made to simplify the description as much as possible. The flowers have not been described because a brief description of them necessitates the use of technical terms probably unfamiliar to the majority of people. There is considerable variance among botanists as to the use of both common and scientific names for some of the Ribes. The names given in the Connecticut Botanical Society Catalogue of Flowering Plants and Ferns are used here. The local ranges are taken from the Station blister rust control records and the descriptions are based on the Standard Cyclopedia of Horticulture, by L. H. Bailey, and on Gray's New Manual of Botany as revised by Robinson and Fernald.

A rough identification of the Ribes of Connecticut may easily be made in the field by types of Ribes. They may be grouped into four types. The first three comprise the currants, which are characterized by smooth stems, without spines or bristles, except *lacustre;* leaves heart-shaped and large except *lacustre, aureum,* and *odoratum;* branches round, except *americanum;* racemes or flower clusters many flowered.

Group I. Black Currants. Characterized by black fruit, and golden yellow or amber resin dots on the underside of the leaves. To this group belong the

A. *Cultivated European Black Currant, Ribes nigrum* Linn. This currant has resin dots only on the under side of the leaf. The stems are round. It seldom escapes from cultivation. The leaves and stems have a strong disagreeable odor when crushed.

B. *Wild American Black Currant, Ribes americanum,* Mill. This currant has resin dots on both sides of the leaf, although those on the upper side are sometimes hard to see without a magnifying glass. The stems, particularly on the newer growth, are angular. The odor of the leaves and stem when crushed is heavy and disagreeable, but not nearly so noticeable as that of the European black currant. It is usually found growing wild, but it is sometimes cultivated. Found throughout the state.

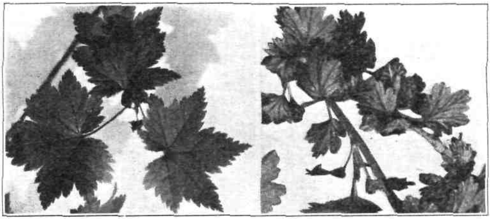
Group II. Flowering Currants, spice bush or clove bush. Characterized by small leaves, thick and leathery, resembling in outline a gooseberry leaf more than the usual currant leaf. Flowers yellow with a pleasing odor. Found under cultivation throughout Connecticut.

A. *Flowering Currant, Ribes aureum,* Pursh. Leaves are wedge-shaped at base and smaller than those of odoratum, either hairy or smooth. Fruit black, red or yellow.

B. *Flowering Currant,* Spice Bush, Clove Bush, *Ribes odoratum,* Wendl. Leaves square-shaped at base, smooth. Fruit black.

Group III. Red Currants. Characterized by red or white fruit. To this group belong

A. *Cultivated Red and White Currants, Ribes vulgare,* Lam. Bushes erect, occasionally five feet in height. Fruit red, white or striped, juicy. Found growing wild as well as under cultivation. Common in northern Connecticut, growing wild in fence rows along roadsides, in moist woods and on the borders of swamps. Less often found growing wild in southern Connecticut.



a *b*

FIGURE 42. *a*, Skunk currant, *Ribes prostratum;* *b*, Smooth gooseberry, *Ribes oxyacanthoides.*

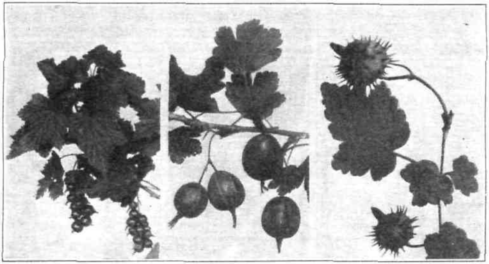
B. *Skunk Currant, Ribes prostratum,* L'Her. Found only growing wild. It is a reclining plant, with spreading stems and upright branches. It emits a strong, disagreeable odor when crushed. Has a very limited range in Connecticut. Reported only in Colebrook, Norfolk, northern Salisbury, and on Canaan Mountain. Very prevalent in Colebrook, Norfolk and on Canaan Mountain, less so in northern Salisbury.

Group IV. Gooseberries. Gooseberries are characterized by nodal spines and often bristly stems and fruit. They usually grow erect. The racemes or flower clusters have few flowers. The fruit of the wild species range in color from red to a dark purple.

A. *Prickly Gooseberry, Ribes cynosbati,* Linn. Sometimes reaches a height of six to seven feet. Branches spreading. Spines one to three at base of leaf stalks and one-quarter to two-fifths inches long. Stem bristles are few and weak or none. Leaves are usually heart-shaped at the base, often downy under-

neath. Fruit is red, prickly, edible. Very prevalent throughout northwestern Connecticut in dry woods, pastures, thickets and in moist places. It is less prevalent in northeastern Connecticut and rare in central and southern Connecticut.

B. *Smooth Gooseberry, Ribes oxyacanthoides,* Linn. Called by some authors *Ribes hirtellum.* Rarely reaching a height of four feet. Branches slender, usually unarmed, sometimes with small spines; occasionally the base of vigorous shoots are bristly. Leaves are usually wedge-shaped at the base, smooth or occasionally slightly downy. Leaf stem often with long hairs. Fruit smooth, purple, edible. Prevalent throughout northeastern Connecticut, principally in swamps but also found on dry locations. It is less prevalent in the northwestern part of the state, and rather rare in central and southern Connecticut.



a *b* *c*

FIGURES 43. *a,* American black currant, *Ribes americanum; b,* Cultivated gooseberry, *Ribes grossularia; c,* Prickly gooseberry, *Ribes cynosbati.*

C. *Cultivated Gooseberry, Ribes grossularia,* Linn. There are several varieties of the cultivated gooseberry. Varies in growing habit from upright bushes, reaching three feet in height, to low reclining bushes. It sometimes escapes from cultivation.

Two wild Ribes very rarely found in Connecticut do not fit into any of these four groups. They are the swamp black currant, *Ribes lacustre,* Poir. and the swamp red currant, *Ribes triste,* Pall. The swamp black currant has slender weak stems covered with dense bristles. The leaves resemble the prickly gooseberry, but are more slender and more deeply lobed; the fruit is purple to

black, and bristly. The swamp red currant is a low shrub with creeping, often rooting stems; the stems and branches are smooth; leaves are large, broader than long and resemble a red maple leaf; they are densely hairy underneath; fruit small, smooth and a smoky-purple color.

Where to Plant White Pine

The contents of this pamphlet may tend to create the impression that white pine is not a desirable tree to plant nor to favor in forest management. Such is not the case. As stated in the introduction, there is no more valuable forest tree in Connecticut than the white pine and there is no tree more likely to pay good returns on money wisely invested in its care. On the other hand, if planted in areas where Ribes are numerous, white pine is a decided risk. To obtain best results it should be planted on areas where Ribes are naturally scarce and where Ribes eradication may be made at a reasonably low cost. Southern Connecticut has few wild Ribes and is favorable to the growing of white pine in this respect.

Avoid planting white pine around swamps in northern Connecticut, because of the prevalence and difficulty of eradicating Ribes. It is best to plant white pine in mixture with other species, preferably hardwoods, in order to lessen the weevil danger. Mixed planting with hardwoods, however, should not be undertaken without first obtaining the advice of a competent forester as to species of hardwoods to use, spacing and relative numbers and position of the species used. Such advice may be had free by writing to the Station Forester, Connecticut Agricultural Experiment Station, Box 1106, New Haven.

Always eradicate currants and gooseberries as instructed before planting white pine.

Bulletin 315 April, 1930

TWENTY-NINTH REPORT
CONNECTICUT STATE ENTOMOLOGIST
1929

W. E. BRITTON, Ph.D.
State Entomologist

Connecticut
Agricultural Experiment Station
New Haven

The bulletins of this station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

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CONTENTS

Page

Letter of submittal 483
Financial statement 484
Department staff and work 485
Exhibits 487
Collection of insects 488
New equipment 488
Summary of office and inspection work 488
Publications of the department, 1929 489
Entomological features of 1929 490
Fruit insects 491
Vegetable insects 493
Shade and forest tree insects 495
Insects attacking ornamental shrubs and vines 497
Insects attacking flowers and greenhouse plants 498
Field and lawn insects 499
Household insects 499
Miscellaneous insects 500
Convention of entomological workers 500
Inspection of nurseries in 1929 502
Connecticut nursery firms certified in 1929 508
Inspection of imported nursery stock 516
Inspection of apiaries in 1929 519
Gipsy moth work in Connecticut in 1929 529
The cost of spraying woodland in Connecticut for the control of the gipsy moth 543
The spread and control of the European corn borer in Connecticut 563
Tests of various apple sprays 569
A study of various oils and emulsions for killing the eggs of the European red mite 571
Experiments with oils on a double infestation of aphids and European red mites at the experiment farm at Mount Carmel 576
Notes on life history and control of the pine leaf scale 578
The Mexican bean beetle in Connecticut 581
Fuller's rose beetle in Connecticut 585
An outbreak of small aquatic flies in a filter plant 587
The Japanese beetle: scouting and quarantine enforcement 588
The Asiatic beetle: quarantine and inspection 599
The revised insect pest law 604
Spread of the satin moth 605

Page
The Asiatic garden beetle in Connecticut 607
Mosquito control in Connecticut in 1929 608
Miscellaneous insect notes 614
European pine shoot moth in Hamden 614
Leaf rollers on rose 614
Strawberry whitefly 614
Lyctus beetles 614
Injury to young coniferous trees by white grubs 614
Kermes on black oak 615
Aphids on ferns 615
Rose midge in greenhouse 615
Stalk borer infesting a corn field 615
Injury to golf greens by Crambus larvae 616
Grass injured by white grubs 616
The pit-making oak scale 617
Index 619

Authorship

For bibliographical purposes all material published in this bulletin, unless otherwise indicated, should be credited to W. E. Britton.

Illustrations

The illustrations in this bulletin are from the following sources: Figures, all from line drawings; 45, 50, 52, 53, 54, 55, 56, 57 and 58, maps prepared by B. H. Walden; 46, 47, 48 and 49 by R. B. Friend; 51 by Philip Garman. Plates, all from photographs; XIII, a, from Massachusetts Department of Agriculture; XXI, a and c, from Burgess and Crossman, Bureau of Entomology, *United States Department of Agriculture*; XVI, XVII, and XIX, a, by J. P. Johnson; XXV, b, by W. O. Filley; XIII, b, and XIV by W. E. Britton; XXVIII by R. C. Botsford; all others by B. H. Walden.

TWENTY-NINTH REPORT
CONNECTICUT STATE ENTOMOLOGIST

1929

To the Director and Board of Control of the Connecticut Agricultural Experiment Station:

I have the honor to transmit herewith my twenty-ninth report as State Entomologist of Connecticut. A comprehensive account of the Oriental peach moth, prepared by Doctor Garman, has been published as Bulletin 313. The official inspection and control operations prescribed by Statute are given in some detail, as well as a review of the various quarantines and their enforcement. One important development of the year was the discovery in Connecticut of the Mexican bean beetle. Other brief papers indicate the research and observations of members of the department staff.

Respectfully submitted,

W. E. BRITTON,
State and Station Entomologist.

FINANCIAL STATEMENT

Report of Receipts and Expenditures of the State Entomologist July 1, 1928, to June 30, 1929.

RECEIPTS

Insect pest appropriation, biennial period ending June 30, 1929	$60,000.00	
Deficiency appropriation	15,000.00	
Miscellaneous receipts, refunds, etc.	570.68	
	$75,570.68	
Expended to June 30, 1928	38,915.41	
Balance available July 1, 1928		$36,655.27

EXPENDITURES

Salaries	$18,710.00	
Labor	7,936.43	
Stationery and office supplies	142.39	
Scientific supplies (chemicals)	22.94	
Scientific supplies (other laboratory supplies)	22.58	
Scientific supplies (photographic supplies)	95.11	
Insecticides, etc.	804.11	
Lumber and Small Hardware	3.40	
Miscellaneous Supplies	110.46	
Automobile Oil	144.53	
Fertilizer	10.00	
Telegraph and Telephone	188.02	
Postage	71.50	
Travel expense (outlying investigations)	2,759.29	
Travel expense (meetings, conf., etc.)	364.14	
Travel expense (gasoline for automobiles)	731.44	
Freight, express and parcel post	38.98	
Publications (bulletins, annual reports)	33.25	
Electricity	39.24	
Furniture and fixtures (new)	491.19	
Furniture and fixtures (repairs)	23.45	
Library (books and periodicals)	89.44	
Scientific equipment (new)	570.39	
Scientific equipment (repairs)	1.35	
Automobiles (new)	581.00	
Automobiles (repairs)	339.99	
Tools, machinery and appliances (new)	145.49	
Tools, machinery and appliances (repairs)	2.25	
New buildings and structures	709.69	
Buildings (repairs and alterations)	15.15	
Rent of land and buildings	58.75	
Contingent insurance	54.92	
Miscellaneous contingent expenses	131.84	
Total disbursements	$35,442.71	
Balance on hand June 30, 1929	1,212.56	
		$36,655.27

DEPARTMENT STAFF AND WORK

W. E. Britton, Ph.D., *State and Station Entomologist.*
B. H. Walden, B.Agr., *Photographic and General Work.*
M. P. Zappe, B.S., *Inspection and General Work.*
Philip Garman, Ph.D., *Research Work.*
Roger B. Friend, Ph.D., *Research Work.*
} *Assistant Entomologists.*
J. F. Townsend
B. W. McFarland
John C. Schread, M.S.
W. Theodore Brigham, B.S.
} *Technicians.*
J. Peter Johnson, B.S., *Deputy in Charge of Asiatic and Japanese Beetle Quarantines.*
John T. Ashworth, *Deputy in Charge of Gipsy Moth Work.*
James A. McEvoy, *Assistant in Gipsy Moth Work.*
Robert C. Botsford, *Deputy in Charge of Mosquito Work.*
Mrs. Gladys Brooke, B.A., *Secretary.*
H. W. Coley, Westport
A. W. Yates, Hartford
} *Apiary Inspectors.*

Mr. Walden has continued as chief photographer for the department and has been in charge of the office during the absence of the Entomologist. He has had charge of certain exhibits, and devoted a part of his time to the identification of insects and work on the collection, together with inspection and general work of the department. He has also continued his researches on the imported currant worm, *Pteronidea ribesi* Scop.

Mr. Zappe has continued as chief nursery inspector and with his helpers has inspected all stock in the nurseries of the State. The number of nurseries has increased from year to year. He has also inspected the nursery stock imported into Connecticut from foreign countries. With Mr. Stoddard, of the Botany Department, he has visited a number of orchards in order to gather data on the prevalence of insect pests and to advise owners regarding treatment. Mr. Zappe has spent considerable time identifying insects and caring for the collection as a specialist in the order Coleoptera, or beetles. With Mr. T. M. Cannon and other Federal men, he has helped distribute information regarding the European corn borer throughout the infested area and will have charge of clean-up work next spring, as in former years.

Doctor Garman has devoted some time to mites and dragonflies, but most of his efforts have been placed on the control of the Oriental peach moth, *Laspeyresia molesta* Busck, which has increased in abundance and caused serious injury in many peach orchards. Doctor Garman has succeeded in rearing several parasites of the Oriental peach moth, two of which are quite common in certain orchards and can be reared artificially for liberation in orchards where they are not abundant. In late summer the peach growers requested the Station to undertake the rearing of these parasites, made contributions to a fund and obtained a state appro-

priation for this purpose. Equipment has just been installed for parasite work and will be described later. Doctor Garman has also given much attention to the subject of oil sprays.

Doctor Friend has continued his observations and experiments on treating lawns with lead arsenate as a control for the Asiatic beetle, *Anomala orientalis* Waterhouse. He has also continued observations on the life history and habits of the imported birch leaf-miner, *Fenusa pumila* Klug, which we hope can be completed in another season. Doctor Friend has experimented in the control of the cabbage maggot and the squash-vine borer at the Station farm at Mount Carmel and in coöperation with the gipsy moth men has gathered data on the cost of spraying woodland areas. During the year Doctor Friend has given two courses in entomology in Yale University, and has given considerable attention to the Diptera in the Station collection.

Mr. John T. Ashworth has continued as deputy in charge of gipsy moth control work with headquarters at Danielson, with Mr. J. A. McEvoy as assistant. This work includes scouting and creosoting egg-clusters, spraying around infestations, collecting parasitized material, liberating parasites, and is conducted in coöperation with the Federal Plant Quarantine and Control Administration and Bureau of Entomology; it has been carried on vigorously during the past season.

Mr. J. Peter Johnson has continued in charge of the quarantine enforcement and control of the Japanese beetle and the Asiatic beetle that is conducted in coöperation with the Federal Plant Quarantine and Control Administration. An office has been maintained in Shelton, but on July 1, 1929, it was moved from the Hurley Building to the Pierpont Building on Howe Street. Mr. Johnson has had a force of men sufficient to make the necessary inspections, issue the required certificates, patrol the principal highways leading out of the quarantined area, visit growers, and in summer to scout for beetles in other cities and towns in Connecticut outside of the quarantined area.

Mr. Robert C. Botsford has continued as deputy in charge of the work of eliminating mosquitoes. He makes preliminary surveys, supervises the ditching work, and maintains the ditches that have been accepted for state maintenance under Section 2, Chapter 68, Public Acts of 1923. Important new work has been done during the season in Old Lyme and Hamden.

Four technicians are now employed: B. W. McFarland, on Asiatic beetle investigations and control; J. F. Townsend, on Oriental peach moth investigations and control; J. C. Schread and W. Theodore Brigham, on Oriental peach moth parasites, beginning late in the season.

Mr. A. F. Clark was employed from July 1 to August 31; Mr. J. G. Conklin from June 18 to September 21, and Mr. Harold

B. Bender from July 1 to September 30, to assist Mr. Zappe in the work of inspecting nurseries.

Mr. W. E. Devine was employed for the school vacation as a general helper in office and laboratory.

Mr. Neely Turner, who is employed by the Crop Protection Institute on horticultural oil spray investigations, has been associated with the department and has been furnished office and laboratory facilities by the Station.

Mr. A. W. Yates, Hartford, and Mr. H. W. Coley, Westport, have continued to serve as apiary inspectors as in former seasons on a *per diem* basis.

Mrs. Gladys Brooke has served as Secretary to the department. During her vacation, Mrs. A. D. McDonnell was employed for part time to attend to the correspondence and other necessary work.

Miss Hazel B. Gillespie, a graduate student in Yale University, was employed during the summer vacation period to index the entomological literature in the journals, and the bound volumes are now nearly all indexed.

All members of the department staff and others mentioned have rendered faithful and efficient services, without which it would have been impossible to obtain the results already accomplished. To them the Entomologist hereby expresses his appreciation and thanks.

The attention of the Entomologist has been given to the office correspondence and to directing the research, inspection, quarantine and control work of the department. Much time has been devoted to meetings and conferences regarding some phase of insect control. The Entomologist has retired from the associate editorship of the *Journal of Economic Entomology*, but he is still chairman of a committee on the project of horticultural oil sprays of the Crop Protection Institute, insect pest reporter in Connecticut for the Insect Pest Survey of the Bureau of Entomology, chairman of the Tree Protection Examining Board of Connecticut, and Superintendent of the Connecticut Geological and Natural History Survey, and has devoted some time to each of these matters.

The principal activities of the department appear in greater detail in the following pages of this report.

Exhibits

Several exhibits were made by the department during the season. The New Haven Garden Club requested that an exhibit of the Asiatic beetle be made at the spring flower show in Trinity Parish House, New Haven, on May 17. This exhibit was shown and later was repeated at the New Haven Lawn Club. The same material was shown for two weeks in the show window of a hardware store.

On August 5, an exhibit under the auspices of the Litchfield Garden Club was set up in the high school at Litchfield and remained for a week. On October 8 an exhibit was made at the meeting of the Madison Garden Club, at Madison.

A small exhibit of insects attacking vegetable crops was shown in Hartford, December 3 and 4, at the annual meeting of the Connecticut Vegetable Growers Association. A small exhibit of European corn borer and injury caused by this pest was arranged for a meeting to consider the corn borer quarantine, held at the Station, November 7.

An exhibit of Oriental peach moth material was also prepared for use in Glastonbury.

Collection of Insects

Additions to the Station insect collection are constantly being made by members of the staff and by correspondents. Though no important collecting trips were made, Doctors Garman, Friend and Britton collected in Portland, East Haddam, Salem and Montville in June.

Mr. W. E. Manchester, Pleasant Valley, sent in some specimens of mayflies, flies and dragonflies taken near his home. Prof. C. P. Alexander of Amherst, Mass., collected in Norfolk and Granby chiefly for craneflies, but saved all Diptera and sent many specimens for our collection. Dr. E. P. Felt and Mr. S. W. Bromley, of Stamford, also contributed many specimens of Diptera and some captures in other orders.

New Equipment

Some second-hand filing cabinets and book sections were purchased and a portion installed in the office of the department; the remainder and our old adding machine were assigned to the Japanese beetle office in Shelton. A new adding machine and typewriter were purchased for the office and a new high-power compound microscope and 5 x 7 view camera for the laboratory of the department. An engineer's dumpy level and planimeter were bought for use on mosquito elimination work.

Late in the season, there was purchased for the parasite work a large electric refrigerator and a humidifier. Several incubators, breeding cages, and a constant high-temperature room were constructed by our own technicians.

SUMMARY OF OFFICE AND INSPECTION WORK

409 samples of insects received for identification.
288 nurseries inspected.
288 regular certificates granted.
222 duplicate certificates issued for filing in other states.

1 special raspberry certificate granted.
8 special miscellaneous certificates granted.
104 nursery dealer's permits issued.
258 shipper's permits issued to nurserymen in other states.
352 parcels of nursery stock inspected and certified.
42 bales of mountain laurel and other decorative material inspected and certified for shipment.
22,000 narcissus bulbs inspected and certified.
1,084 shipments of corn and other seed inspected and certified.
334 blister rust control area permits issued.
32,926 Japanese beetle certificates on nursery and floral stock and farm products.
855 Asiatic beetle certificates on soil and plants.
76 orchards and gardens examined.
23 shipments, containing 225 cases, 2,022,475 plants imported nursery stock inspected.
11 shipments or 47 per cent found infested.
990 apiaries, containing 9,559 colonies, inspected.
2 apiaries and 3 colonies found infested with European foul brood.
46 apiaries and 115 colonies found infested with American foul brood.
4,369 letters[1] written on official work.
942 circular letters sent out.
270 post cards sent out.
23 reports to Federal Plant Quarantine and Control Administration.
2,453 bulletins, etc., mailed on request or to answer inquiries.
36 packages sent by mail or express.
54 lectures and addresses at meetings.

PUBLICATIONS OF THE DEPARTMENT, 1929

W. E. Britton:

Twenty-Eighth Report of State Entomologist, Bull. 305, 100 pages, 16 plates, 8 figures. June, 1929.

The European Corn Borer, a Menace to Corn, Vegetable and Garden Plants, Bull. Imm. Inf. 63, 4 pages, 2 figures, 12,000 copies. April 17, 1929.

Japanese Beetle Quarantine, Bull. Imm. Inf., 4 pages, 4 figures, 6,250 copies. May 1, 1929.

Asiatic Beetle Quarantine, Bull. Imm. Inf. 65, 4 pages, 4 figures, 5,000 copies. May 3, 1929.

Satin Moth Quarantine, Bull. Imm. Inf. 66, 3 pages, 2 figures, 1,200 copies. May 3, 1929.

Control of Ant Invasions, Bull. Imm. Inf. 67 (Revision of No. 17), 6 pages, 2 figures, 5,000 copies. August 22, 1929.

Report of Committee on Injurious Insects, Proceedings 38th Annual Meeting Conn. Pom. Society, 28. April, 1929.

Insects Injuring Vegetable Crops in 1928, Report of Committee on Insects, Conn. Veg. Growers Assn., 26.

Thirteenth Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1927-1928, Bull. 45, 32 pages, 3 plates, 2,500 copies. August 13, 1929.

Three Corn Crop Pests, Rural New-Yorker, *88:* 1225. October 5, 1929.

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[1] Including 1,078 written at the Shelton Japanese Beetle office.

Philip Garman:

The Oriental Peach Moth Situation, Proceedings, 38th Annual Meeting, Conn. Pom. Society, p. 102. April, 1929.

The Use of Oil Sprays, Proceedings, 38th Annual Meeting, Conn. Pom. Society, 50. April, 1929.

M. P. Zappe:

Russeting of Apples in 1928, Proceedings, 38th Annual Meeting, Conn. Pom. Society, 54. April, 1929.

Philip Garman and M. P. Zappe:

Control Studies on the Plum Curculio in Connecticut Orchards, Bull. 301, 68 pages, 8 plates, 12 figures. May, 1929.

R. B. Friend:

The Asiatic Beetle in Connecticut, Bull. 304, 84 pages, 4 plates. June, 1929.

Control of the Asiatic Beetle in Lawns, Bull. Imm. Inf. 62, 6 pages, 5 figures, 4,000 copies. March, 1929.

Control of Insects Affecting Truck Crops, Report Conn. Veg. Growers Assn. for 1928, 28.

R. C. Botsford:

Progress in Mosquito Elimination in Connecticut during 1928, Proceedings, 16th Annual Meeting N. J. Mosquito Exter. Assn., 120. July, 1929.

Neely Turner:

Tests for Oil Sprays, Proceedings, 38th Annual Meeting, Conn. Pom. Society, 49.

Variation in Resistance of Aphids to Toxic Sprays, Jour. Econ. Ent., **22**: 323. April, 1929.

ENTOMOLOGICAL FEATURES OF 1929

The weather for the season of 1929 was unusual. After a rather mild winter without heavy snowfall or very low temperatures, the growing season started with cool and moist weather during April and May. Then higher temperature prevailed, but there was a shortage in precipitation for the months of June, July and September.

The rainfall for August was only slightly below normal, but nearly all of it fell in one shower on August 11.

In general, aphids were present and caused considerable damage. There was a marked spread of the European corn borer, and the *Mexican bean beetle was discovered in the state for the first time.* For the insect notes on the following pages, the writer is indebted to Mr. Zappe and Doctor Garman (fruit insects) and to Mr. A. E.

Wilkinson, Vegetable Specialist, extension department, Connecticut Agricultural College, Storrs (vegetable insects), for a part of the information.

Fruit Insects

As the apple crop was rather light, other things being equal, insect injury to the fruit was perhaps more conspicuous than in a year of heavy yield, and the percentages of perfect fruit were smaller.

Early in the season, eggs of the green apple aphid, *Aphis pomi* DeGeer, were abundant in apple orchards in New Haven County. After the eggs hatched, this species and the rosy apple aphid, *Anuraphis roseus* Baker, were rather abundant, but both Syrphid larvae and lady beetles were present and feeding upon them. It seemed probable that these predatory insects would control the aphids so that little or no aphid injury would result. But later in the season both kinds were very abundant in some orchards and the foliage was severely curled, though this happened too late to result in serious injury to the fruit crop. Mr. Zappe reported the rosy aphid as being present in apple orchards as follows: Bantam, May 13; Meriden, May 16; Branford and Guilford, May 29; Niantic, June 5; Farmington and Somers, June 6; East Hampton, June 10; Montville and Lebanon, June 12; Ledyard and Center Groton, June 13, and Waterbury, August 13. The writer observed a heavy infestation of rosy aphids on a large apple tree in a city yard in New Haven, June 18. Lady beetles were abundant. Specimens of the green apple aphid were received from Hamden, April 18.

The woolly apple aphid, *Eriosoma lanigerum* Hausman, was present in usual numbers, and specimens were received from Hamden, June 22.

The currant aphid, *Myzus ribis* Linn., and the cherry aphid, *Myzus cerasi* Fabr., are usually present each year throughout Connecticut. Specimens of the former were received from Woodbury and of the latter from New Haven on June 3.

The pear psylla, *Psylla pyricola* Forst., was reported as being prevalent and injurious in the eastern part of the state. According to Doctor Garman, this insect was fairly abundant in one orchard, but rather scarce in all other orchards visited in New Haven County on May 24. In Fairfield and New Haven Counties it seemed to be present in average abundance on July 24, though less abundant than in 1928.

The apple red bug, *Lygidea mendax* Reut., was absent in nearly all apple orchards throughout the state.

The San José scale, *Aspidiotus perniciosus* Comst., is now rather scarce and hard to find, but it was present in several nurseries and specimens were received from Waterbury, August 13.

The European fruit scale, *Lecanium corni* Bouché, and the rose scale, *Aulacaspis rosae* Bouché, were both received on blackberry canes from West Haven, on June 14.

The strawberry whitefly, *Trialeurodes packardi* Morrill, caused considerable injury in a strawberry field at Branford.

The pear midge, *Contarinia pyrivora* Riley, was present in certain orchards and caused the immature fruit to drop. Work of this insect was observed at Branford, May 29, and specimens were received from Mystic, June 10.

There was perhaps more than the usual amount of injury from the apple maggot or railroad worm, *Rhagoletis pomonella* Walsh. The best control is obtained by sprays of lead arsenate in July and early August and by the destruction of drops. Specimens were received from Plantsville, September 24; New Haven, September 28 and October 11, and from Vernon, November 6.

In Wallingford early in the season, slight injury was reported to fruit from green fruit worms, *Xylina antennata* Walker.

The Eastern tent caterpillar, *Malacosoma americana* Fabr., has at last become scarce over a greater portion of the state. A few nests were observed in Litchfield County, where several successive freezes killed the cherry leaves and the caterpillars died. These nests failed to increase in size and they did not contain living caterpillars. This insect may be considered as having now reached its minimum. In a few years it will probably again become prevalent.

Larvae of one of the lappet moths, *Tolype velleda* Stoll., feeding upon apple foliage were received from Woodmont, August 2, and from Waterbury, August 13. This insect is never sufficiently abundant to be considered as a pest.

Occasionally apple trees are found with large burrows of the leopard moth, *Zeuzera pyrina* Linn., in trunk or branches. Specimens of such injury were received from South Manchester, May 31, and from Milford, August 29.

The fall cankerworm, *Alsophila pometaria* Harris, though less prevalent than last year, was present and caused some damage in certain localities. This was true in portions of New Haven and New London Counties, where trees were stripped in 1928. Specimens were received from Clintonville, May 16, and from East Hampton, June 10.

The bud moth, *Tmetocera ocellana* Schiff., caused some injury in the vicinity of Litchfield, in May, by devouring the buds on young trees. It was also reported from Kensington, May 16. There was little injury in other portions of the state.

Considerable surface injury to stored apples by the red banded leaf roller, *Eulia velutinana* Walker, was noticed about November 1, in New Canaan and Wilton. This insect was reported as being rather abundant in Fairfield County.

Rather more than the usual proportion of fruit was injured by the codling moth, *Carpocapsa pomonella* Linn. Not only was this true of the first brood but there was also considerable side injury by the larvae of the second brood. On the whole, this insect was well controlled where the trees were properly sprayed.

One of the most destructive insects of the year is the Oriental peach moth, *Laspeyresia molesta* Busck, which was prevalent in the central portion of the state and caused serious injury in some of the peach orchards.

In certain orchards in Wallingford, it caused less damage than five years ago, but in other orchards not many miles distant between 75 and 100 per cent of the peaches were wormy at harvest time. Quinces were also ruined. Twig injury to peach trees was prevalent in June and July in Hartford and New Haven Counties.

Unusually abundant everywhere in 1929 was the plum curculio, *Conotrachelus nenuphar* Herbst., which injured a large proportion of the fruit in apple orchards, especially near woodlands. Mr. Zappe reports it as being very abundant on apple in the following localities: Niantic, June 5; Somers, June 6; East Hampton, June 10; Ledyard, June 13; a few at Lebanon, June 12. Reported as present at South Windsor, and Farmington, June 6; Glastonbury and Montville, June 12; Burlington and Unionville, June 26; Waterbury, August 13; Collinsville, August 26, and Norwalk, August 27. It was reported on peach from Putnam, July 26, and Collinsville, August 26.

The pear leaf blister mite, *Eriophyes pyri* Pag., is usually present to some extent on pear and apple. Specimens were received on pear from Glastonbury, May 22.

The European red mite, *Paratetranychus pilosus* C. and F., was probably less prevalent than in 1928, though moderately abundant in apple orchards in Hartford and New Haven Counties. There were many eggs in orchards in New Haven County in March, and there was a rather heavy infestation in Kensington in May. Mr. A. T. Henry, of Wallingford, reports few eggs present this winter, 1929-1930, but Prof. J. A. Manter of the Connecticut Agricultural College at Storrs writes that the eggs are abundant there.

Vegetable Insects

Perhaps the most important item to include under this heading is the discovery that the Mexican bean beetle, *Epilachna corrupta* Muls., has appeared in Connecticut. It was first discovered and reported by Dr. E. P. Felt, and afterwards found to be distributed throughout the western half of the state. A more complete account is given in another part of this report, page 581.

Flea beetles, *Epitrix cucumeris* Harris, were very abundant and caused injury to crops of potato, tomato, egg-plant, cucumber, early squash, melon and tobacco. Sprays of pyrethrum-soap preparations bave been successfully used as a remedy by some growers.

The striped beetle, *Diabrotica vittata* Fabr., was very abundant at the Station farm at Mount Carmel.

The Colorado potato beetle, *Leptinotarsa decemlineata* Say., was unusually abundant in most localities throughout the state.

The asparagus beetle, *Crioceris asparagi* Linn., was present in the usual abundance. Specimens were received from Rockville, May 28, and from West Haven, July 30.

The squash lady beetle, *Epilachna borealis* Fabr., was received from Higganum, July 15.

The margined blister beetle, *Epicauta marginata* Fabr., was reported as injuring Swiss chard at Hamden, July 23.

In general, cutworms were less troublesome than usual at the time when cutworms usually cause injury, but in late June and early July, certain kinds, especially a black cutworm, appeared in certain fields in New Haven County and caused considerable injury to sweet corn and potatoes. Such injury was reported from Meriden, Yalesville, Wallingford, Foxon, Branford, Highwood, Woodbridge, Woodmont, Orange, and North Haven. Though specimens were collected, we were unable to rear the adults.

The squash vine borer, *Melittia satyriniformis* Hübner, was very abundant at the Station farm at Mount Carmel.

The stalk borer, *Papaipema nitela* Guen., was exceedingly abundant throughout the state and in the stems of various plants. Specimens were received in corn from Bethlehem, Cheshire, Durham, Hamden, New Haven, Shelton, Wallingford, Waterford, Westport and Winsted; in tomato, from Cheshire, and in beans from West Haven.

The corn ear worm, *Heliothis obsoleta* Fabr., was more abundant than usual and was present over a longer period.

The first specimens were received on July 15, and from then until frost, it was observed. Specimens were received from Hamden, Hartford, New Haven, Plainville, Plantsville, West Suffield and Woodbridge. It was also reported from Niantic.

The zebra caterpillar, *Mamestra picta* Harr., feeding upon the shoots of asparagus, was received from Meriden, June 10.

The cabbage worm, *Pontia rapae,* Linn., and the cabbage looper, *Autographa brassicae* Riley, were present in usual abundance. The diamond-back caterpillar, *Plutella maculipennis* Curtis, was unusually abundant and was present in nearly every field where cabbages were grown.

The European corn borer, *Pyrausta nubilalis* Hübn., has spread rapidly in 1929, and 38 new towns have been placed under

quarantine. This insect will be discussed in greater detail in another part of this report. Larvae were received from Uncasville, October 7.

A green noctuid larva eating into a green pea pod was received from West Hartford, June 3.

The army worm, *Heliophila unipuncta* Haw., was brought to the Station, June 24, from Woodmont, where it was injuring corn in connection with cutworms.

The cabbage maggot, *Hylemyia brassicae* Bouché, was everywhere abundant throughout the state and untreated plants were ruined. Plants kept treated with corrosive sublimate after setting produced a good crop.

No reports were received of injury by the carrot rust fly, *Psila rosae* Fabr., and there was little or no damage from the spinach leaf miner, *Pegomyia hyoscyami* Panz.

The squash bug, *Anasa tristis* DeGeer, was present in usual numbers. Specimens were received from Higganum, July 15.

Aphids caused great injury to potato, tomato, egg-plant and turnip during midsummer and later. Early in the season, though aphids were present, Syrphid larvae and lady beetles were abundant and were expected to keep the aphids in check.

Shade and Forest Tree Insects

The arborvitae leaf miner, *Argyresthia thuiella* Pack., continues to injure trees in certain portions of Connecticut. Specimens were received from Old Lyme, May 15, and from Riverside, May 18.

The larch case bearer, *Coleophora laricella* Hübner, was received from Middlebury, May 18; Norfolk, June 5, and from Storrs, August 5. It was reported from Greenwich by Dr. E. P. Felt.

The European pine shoot moth, *Rhyacionia buoliana* Schiff., is becoming rather common on Scotch and red pine in Fairfield County. Specimens on red pine were received from Darien, August 27, and it was found on red pine in Hamden and vicinity by Doctor Friend.

The white oak leaf miner, *Lithocolletes hamadryadella* Clemens, was received from South Manchester, August 5.

The spiny elm caterpillar, *Euvanessa antiopa* Linn., was received from Fairfield, June 4.

The fall webworm, *Hyphantria cunea* Dru., was reported by Mr. Zappe as being very abundant in the western half of the state.

A small moth, *Nepticula sericopeza* Zell., was reared from the petioles of Norway maple by Doctor Felt, of Stamford. The larva is a leaf miner in the stems and causes many leaves to drop.

The bronze birch borer, *Agrilus anxius* Gory, continues to kill

white birch trees on private grounds. These trees are chiefly the cut-leaf form of the European white birch. Specimens were received from South Glastonbury, May 22.

The white pine weevil, *Pissodes strobi* Peck, was unusually abundant throughout the state.

The imported willow leaf beetle, *Plagiodera versicolora* Laich., has skeletonized many smooth-leaf willows throughout Connecticut. Specimens were received from Wallingford, June 6, and from Southport, July 22.

A small Scolytid heetle, *Pityogenes hopkinsi* Swains., was found breeding under the bark of some dying white pines in a flooded area in Middlebury, May 18.

The imported sawfly birch leaf miner, *Fenusa pumila* Klug., which has spread throughout the state, causes an unsightly appearance to small paper and gray birches often planted for ornamental trees. Specimens were received from Bridgeport, June 10, and from Bantam, August 22.

The larch sawfly, *Lygaeonematus erichsoni* Hart., was received from Gilead, July 2.

Pine sawflies were rather common in 1929. One species, *Neodiprion pinetum* Norton, was received from Portland, July 18, and from New Haven, August 29.

The catalpa leaf miner, probably *Agromyza clara* Mel., has become rather abundant and was found in 31 nurseries, chiefly on *Catalpa bungei*. Specimens were received from Manchester, September 12.

Aphids were rather abundant on trees in 1929. One species, probably *Dilachnus strobi* Fitch, on white pine, was received from Suffield, October 8. The cockscomb elm gall, *Colopha ulmicola* Fitch, was received from Stamford, July 5. The beech woolly aphid, *Prociphilus imbricator* Fitch, which is common on the under sides of the leaves of purple beech, was received from New Haven, June 10. The pine bark aphid, *Adelges pinicorticis* Fitch, is common on the needles and bark of white pine trees everywhere. Specimens were received from New Haven, May 29 and June 3, and from Waterbury July 1. The spruce gall aphid, *Adelges abietis* Linn., is becoming increasingly common on Norway and white spruce and was found in 85 nurseries. Specimens were received from Riverside, May 28; Woodbury, July 22; Branford, September 16, and Greenfield Hill, Fairfield, November 18. The blue spruce gall aphid, *Gillettea cooleyi* Gill., is also on the increase and was found in 62 nurseries.

The oyster-shell scale, *Lepidosaphes ulmi* Linn., continues to be one of the most prevalent of all insect pests. It was found in 78 nurseries in 1929, and was received on willow from New Haven, and on poplar from Greenfield Hill, Fairfield.

The pine leaf scale, *Chionaspis pinifoliae* Fitch, is common on

young pine trees growing in protected situations. Specimens on red pine were received from Old Lyme.

The tulip tree scale, *Toumeyella liriodendri* Gmel., is fairly abundant on tulip tree and magnolia throughout the state. During the season, specimens of this scale were received from Torrington and Bridgeport, and it was reported by Doctor Felt as being locally abundant around Stamford.

Maple trees, especially silver maple, are often attacked by the terrapin scale, *Lecanium nigrofasciatum* Perg. This scale occurs on the small twigs. Specimens were received from Wallingford, July 16.

There are several species of oak gall scales in Connecticut that are globular and attached to the twigs. Specimens identified as *Kermes galliformis* Riley, on pin oak, were received from Wallingford, July 16, and similar gall scales were very abundant on black oak trees in East Rock Park, New Haven.

The golden oak scale, *Asterolecanium variolosum* Ratz., was reported on April 25, as being very abundant on native chestnut oak around New Haven.

The cottony maple scale, *Pulvinaria vitis* Linn., was reported by Dr. E. P. Felt as being locally very abundant in the vicinity of Stamford. It occurs chiefly on silver maple.

Another scale, *Leucaspis japonica* Ckll., is reported by Doctor Felt to have injured Norway and soft maples in Greenwich.

During the past few years there has been much injury to coniferous trees from the attacks of the spruce mite, *Paratetranychus ununguis* Jacobi. Possibly spruce is more commonly injured than other kinds, but occasionally it also attacks pine, arborvitae, and other trees. Specimens of this mite were received from Bristol, June 13.

Insects Attacking Ornamental Shrubs and Vines

A leaf roller, *Archips rosana* Linn., on privet was rather common around New Haven during the season. Specimens were received from New Haven, May 28, and the insect was noticed on several hedges.

The box leaf miner, *Monarthropalpus buxi* Labou., is now present in several localities in Connecticut. Specimens were received from New Canaan, June 1.

The abbot sphinx, *Sphecodina abbotii* Swains., was prevalent on Virginia Creeper and grape throughout the state. Specimens were received from New Haven, July 9; Shelton, July 16; Granby, July 27, and Clinton, July 29.

A mite, *Phyllocoptes schlectendali* Nalepa, was found on the writer's privet hedge in May. Specimens were also received from New Haven, June 13. This mite curls the leaves on the new tips but on trimming the hedge, most of these tips are clipped off.

On the writer's hedge, evidence of the pest wholly disappeared later in the season.

The black vine weevil, *Brachyrhinus sulcatus* Fabr., and the strawberry weevil, *Brachyrhinus ovatus* Linn., are rather abundant and cause injury to young conifers by eating the bark of the roots. Larvae of the former were received from Norwalk, and the latter from Cromwell.

The euonymus scale, *Chionaspis euonymi* Comst., is reported by Dr. E. P. Felt as being locally abundant around Stamford.

The white scale or West Indian peach scale, *Aulacaspis pentagona* Targ.-Tozz., has for a number of years infested privet, flowering peach, *Catalpa bungei*, and other trees and shrubs in Fairfield County. Doctor Felt reports that a scale, probably this species, has been injurious at Greenwich.

Insects Attacking Flowers and Greenhouse Plants

The verbena bud worm, *Olethreutes hebesana* Walker, was received July 23 from Durham, where considerable injury was caused to plants in a verbena bed.

The iris root borer, *Macronoctua onusta* Grote, was received from New Haven, August 27.

The variegated cutworm, *Peridroma margaritosa* Haw., var. *saucia* Hübn., was very abundant and injured various plants in greenhouses during April.

The greenhouse leaf tyer, *Phlyctaenia ferrugalis* Hübn., was reported as causing considerable injury to plants in greenhouses in Shelton, May 24.

The chrysanthemum gall midge, *Diarthronomyia hypogaea* Loew, was received from Norwich, July 19, where it caused injury in a greenhouse.

The columbine leaf miner, *Phytomyza aquilegiae* Hardy, was present in many gardens in 1929. Specimens were received from Bridgeport, August 27.

The tarnished plant bug, *Lygus pratensis* Linn., causes considerable injury by sucking the sap from various kinds of plants, especially dahlia and aster. Specimens were received from Thomaston, July 13; Naugatuck, July 29, and from Harwinton, August 3.

The four-lined leaf-bug, *Poecilocapsus lineatus* Fabr., is always present in gardens and injures the tender terminal leaves by sucking out the sap, which results in circular transparent spots. Specimens were received from Hamden, June 12, and from New Haven, July 29.

The cottony cushion scale or fluted scale, *Icerya purchasi* Mask., on acacia in greenhouse, was received from Norwalk, September 5.

The common mealy bug, *Pseudococcus citri* Risso., was received on Impatiens, from Hartford, September 17.

The margined blister beetle, *Epicauta marginata* Fabr., was received from West Haven, July 29, where it was feeding upon the leaves of a variegated foliage plant.

Fuller's rose beetle, *Pantomorus godmani* Crotch, was brought to the Station on September 5 from a greenhouse in Norwalk, where it was feeding on the blossoms of acacia.

The bulb mite, *Rhizoglyphus hyacinthus* Banks, is commonly injurious to bulbs and was received from Ridgefield, July 25.

The garden or greenhouse red spider, *Tetranychus bimaculatus* Harv., is very common on phlox, and specimens were received from Old Saybrook, August 7.

The cyclamen mite, *Tarsonemus pallidus* Banks, is a troublesome pest of cyclamen, larkspur, chrysanthemum, and other plants. Specimens were received from Norwalk and Branford.

Field and Lawn Insects

The Asiatic beetle, *Anomala orientalis* Waterhouse, was found in a small private lawn in Bridgeport, May 17 and 25. This is the first infestation discovered in Connecticut outside of New Haven and West Haven. On July 23 an adult was received from New Haven, outside of the former infested area.

White grubs, *Phyllophaga* sp., were responsible for considerable injury to lawns in Connecticut in 1929. Specimens of grubs in soil were received from Greenwich, April 25; from East Hampton, May 1; from Salisbury, August 15, and from Stafford Springs, September 11. Lawns in Glastonbury were injured and reports received September 18. The grubs from Salisbury and Stafford Springs were nearly all *Phyllophaga fusca* Fröh., according to Doctor Friend. Two adults of *P. gracilis* Burm. were received from Clinton, August 26.

The chinch bug, *Blissus leucopterus* Say., is responsible for killing the grass in a small spot on a lawn in Hartford. Adults and nymphs were very abundant in this spot. Specimens were received October 1.

Wireworms caused some injury to corn at North Haven. Mr. Walden visited the field July 6 and collected material which he identified as *Melanotus* sp., probably *communis* Gyll.

Tobacco plants were seriously injured by flea beetles, *Epitrix cucumeris* Harris, at Windsor in July.

Household Insects

The dog flea, *Ctenocephalus canis* Curtis, often infests dwelling houses and bites human beings. It was seemingly more abundant than usual in 1929. Specimens were received from Hartford, August 16, and from New Haven, August 19.

Specimens of the carpet beetle, *Anthrenus scrophulariae* Linn.,

were received from Norwalk, July 1, and from West Haven, November 30.

The saw-toothed grain beetle, *Oryzaephilus surinamensis* Linn., which feeds upon cereals and stored grains, was received from Southington, August 2, and from Norwich, August 24.

One species of "silver-fish" or "fish-moth," *Thermobia domestica* Pack., was received from Meriden, October 16, and a small spider-beetle, *Ptinus fur* Linn., from Hartford, November 30. The former injures books by feeding upon the paste used on the bindings and the latter damages wool, fur, clothing, stuffed furniture, seeds and other plant products.

Miscellaneous Insects

An adult of the northern mole cricket, *Gryllotalpa hexadactyla* Perty, was received from Hamden, August 29.

The Japanese beetle, *Popillia japonica* Newman, was somewhat more abundant in Stamford, Bridgeport, New Haven, Hartford and New London, than in 1928. Though nearly all of the cities and larger villages were scouted in 1929 the only new locality for this insect is Willimantic. One specimen was received from Hartford, August 27.

Grubs of the Asiatic garden beetle, *Aserica castanea* Arrow, were discovered in soil in the towns of New Canaan, Fairfield, Ridgefield, Mansfield, Cromwell and Manchester. Adults were collected in New Haven and New London.

The brilliant green-gold beetle, *Chrysochus auratus* Fabr., was thought to be the Japanese beetle, and specimens were received from Warren, July 10; Avon, July 30, and from Woodbury, August 12. This beetle feeds upon milkweed and dogbane, and is much smaller than the Japanese beetle.

The large aquatic bug, *Benacus griseus* Say., leaves the water and is attracted to electric lights. Adult specimens were received from New Haven, June 17, and from Norwalk, July 12.

The leather beetle, *Dermestes vulpinus* Fabr., was received September 30, from Danbury, where it was feeding upon stored rabbit hides.

The cherry tent-maker, *Archips cerasivorana* Fitch, was very abundant on choke-cherry sprouts in Cheshire.

One of the powder-post beetles, *Lyctus opaculus* LeC., was reported in May as injuring the ash wood of an ice box that had been used in the family eight years.

Convention of Entomological Workers

The sixth annual convention of entomologists working in Connecticut was held in the Community House at the Connecticut Agricultural College, Storrs, on Friday, October 25, 1929. These

meetings are for the purpose of bringing together the research men, teachers, field men and amateur collectors in the state, and entomologists in the adjacent states are invited. The program of the 1929 conference was planned to include subjects of vital importance to Connecticut, and several Federal men who are working in coöperation with state men on control projects were asked to present papers. The following entomologists from outside Connecticut presented papers: A. F. Burgess, Melrose Highlands, Mass.; H. L. McIntyre, Albany, N. Y.; L. H. Worthley, Boston, Mass.; C. H. Hadley, Camden, N. J.; and Harold C. Hallock, Westbury, N. Y. About 60 attended the conference. Luncheon was served in the College dining hall. The following program was carried out without a single substitution:

Program

A. M.

10:30 Greeting, Dr. Geo. A. Works, President, Conn. Agr. College, Storrs
Prof. G. H. Lampson, Jr., Conn. Agr. College, Storrs

10:45 Present-Day Opportunities in Entomology,
Mr. A. F. Burgess, Gipsy Moth Control, Melrose Highlands, Mass.

11:15 Chief Entomological Events of the Season in Connecticut.
Dr. W. E. Britton, State Entomologist, Agr. Expt. Sta., New Haven

11:30 Survey of Gipsy Moth Conditions,
Mr. H. L. McIntyre, Department of Conservation, Albany, N. Y.

12:00 Shade Tree Insects in 1929,
Dr. E. P. Felt and S. W. Bromley, Stamford

12:15 Present Status of the European Corn Borer in the United States,
Mr. L. H. Worthley, Corn Borer Control, Boston, Mass.

P. M.

1:00 Luncheon

2:00 Inspection of new Entomological laboratories, Beach Hall

2:30 The Japanese Beetle in the United States,
Mr. C. H. Hadley, Japanese Beetle Control, Camden, N. J.

3:00 Notes on Biology and Methods of Control of *Aserica castanea*,
Mr. Harold C. Hallock, Bur. of Entomology, Westbury, N. Y.

3:30 Some Aspects of Asiatic Beetle Control,
Dr. R. B. Friend, Asst. Ent., Agr. Expt. Sta., New Haven

3:45 An Attempt to Rear Parasites for the Control of the Oriental Peach Moth in Connecticut,
Dr. Philip Garman, Asst. Ent., Agr. Expt. Sta., New Haven

4:15 Katydids as Thermometers,
Prof. J. A. Manter, Agr. College, Storrs

4:30 Insecticide Studies at the Bartlett Research Laboratories in 1929,
Mr. Stanley W. Bromley and Dr. E. P. Felt, Stamford

The following were present: John T. Ashworth, Danielson; R. C. Botsford, New Haven; A. I. Bourne, Amherst, Mass.; W. E. Britton, New Haven; S. W. Bromley, Stamford; A. F. Burgess, Melrose Highlands, Mass.; T. M. Cannon, Norwalk; O. B. Cooke, Danielson; S. S. Crossman, Melrose Highlands, Mass.; E. B. Davidson, Hartford; R. M. De Coursey, Storrs; George B. Durham, Storrs; F. S. Eaton, New Haven; Gustavus

Eliot, New Haven; E. P. Felt, Stamford; B. J. Fitzsimmons, Jr., Hartford; *R. B. Friend, New Haven; C. W. Frink, Brooklyn; Philip Garman, New* Haven; G. H. Geissler, Storrs; L. E. Gibson, Melrose, Mass.; Robert D. Glasgow, Albany, N. Y.; C. H. Hadley, Camden, N. J.; Harold C. Hallock, Westbury, N. Y.; Kenneth N. Hanks, Storrs; Harry C. Helliwell, Shelton; S. P. Hollister, Storrs; Harry Horovitz, Providence, R. I.; C. E. Jennings, Storrs; J. P. Johnson, Shelton; T. H. Jones, Melrose Highlands, Mass.; J. W. Kelley, Jr., Shelton; J. F. Keough, Willimantic; Nathan Koenig, *Storrs; G. H. Lampson, Jr., Storrs; Alvin J. Lannon, Providence, R. I.*; J. W. Longo, Danielson; J. A. Manter, Storrs; J. B. Marshall, Boston, Mass.; B. W. McFarland, New Haven; H. L. McIntyre, Albany, N. Y.; A. E. Moss, Storrs; G. H. Pallman, New Haven; R. H. Patch, Storrs; Saul Phillips, Albany, N. Y.; Chester J. Poliks, Storrs; K. A. Salman, Amherst, Mass.; A. F. Schulz, Storrs; John C. Schread, New Haven; R. A. Spencer, Bloomfield; A. E. Stene, Kingston, R. I.; Dewey G. Steele, *Storrs; J. F. Townsend, Neely Turner, B. H. Walden and B. H. Wilford,* New Haven; R. H. Wallace and Geo. A. Works, Storrs; L. H. Worthley, Boston, Mass.; M. P. Zappe, New Haven.

INSPECTION OF NURSERIES IN 1929

W. E. Britton and M. P. Zappe

In 1929, the regular annual inspection of nurseries, as provided in Chapter 265, Public Acts of 1925, was commenced July 1, and completed October 1, except for a few new nurseries that were registered late in the season. This work was in charge of Mr. Zappe, who was assisted by Messrs. A. F. Clark, J. G. Conklin and H. B. Bender. In a few special cases, assistance was rendered by Mr. Stoddard, Mr. Walden and Doctor Britton.

Mr. Bender is a member of the Botany Department and was employed on this work for three months in order to give particular attention to such plant diseases as might be present in the nurseries.

As in former seasons the gipsy moth scouts were instructed to search with particular care in and around all nurseries within the infested area and to report to the office at once in case any gipsy moth eggs were discovered in a nursery or in close proximity to a nursery during 1929. Also as in preceding years the pine blister rust scouts under Mr. J. E. Riley, Jr., examined all nurseries where the presence of the pine-currant blister rust was reported by the nursery inspectors.

In general, the nurseries were in rather better condition than in 1928, due to the fact that they had been given better cultivation and to the dry season, which was not favorable to the growth of weeds. Plant diseases were somewhat less abundant than in 1928, but some insects were quite as prevalent or more so. Aphids were generally abundant. Spruce gall aphids, both *Adelges abietis* and *Gillettea cooleyi*, were found in a larger number of nurseries than ever before. This is due partly because the number of nurseries

is greater than ever before and partly to a seeming increase in the prevalence of these insects. Spraying during the first half of April with a contact spray to kill the over-wintering females has been practiced in a few nurseries, and will need to be practiced much more extensively if this pest is to be kept in control.

In 13 nurseries no pests were found. Following is a list of the insects and plant diseases found in nurseries in the annual inspection of 1929 and the number of nurseries infested by each:

PESTS FOUND IN NURSERIES IN 1929

Number of nurseries uninfested, 13

INSECTS

Name	No. nurseries
Aleyrodes	25
Anisota rubicunda	1
stigma	1
Aphids, apple, green	55
woolly	64
on Bechtel's crab	6
beech (woolly)	2
birch	8
Celastrus	1
cherry	4
chestnut	1
chrysanthemum	1
cotoneaster	1
Crataegus	23
currant	2
Cytisus	1
elm	5
elm (woolly)	10
Euonymus	2
fir	2
flowering crab	10
forsythia	1
hollyhock	1
larch (woolly)	3
Lonicera	1
maple	5
mountain ash	12
oak	1
pear	4
red pine	1
white pine	1
white pine (woolly bark)	75
plum	3
poplar	1
poplar leaf stem gall	1
Prunus pissardi	3
rose	4
spirea	3
spruce	3
Adelges abietis	85
Gillettea cooleyi	62
sumac	1
Aphids on viburnum	4
weigelia	1
willow	7
Apple and thorn skeletonizer	20
Apple case bearer	2
Borer, apple (*Zeuzera*)	2
Crataegus	1
currant	1
lilac	6
linden	2
maple	1
oak (*Agrilus*)	1
peach	6
rose (*Agrilus*)	2
white pine weevil	37
willow (*Cryptorhynchus*)	6
(*Saperda*)	1
Brachyrhinus ovatus	2
sulcatus	2
Bugs on ash (Capsids)	1
Cutworms	1
Elm case bearer	9
Elm leaf beetle	9
European pine shoot moth	7
Fall webworm	26
Flea beetle, viburnum	1
Crepidodera helxines	3
Epitrix cucumeris	2
Galls, elm (cockscomb)	11
linden	2
oak	5
tulip tree leaf	7
willow	1
Io larvae	3
Juniper webworm	12
Lace bugs, birch	1
juglans	1
kalmia	1
quince	1
rhododendron	41
sycamore	2

Name	No. nurseries
Leaf hoppers, apple	12
ash	1
Crataegus	1
Helenium	1
Japanese maple	1
maple	1
mountain ash	2
poplar	2
rose	1
weigelia	1
wisteria	1
Leaf-miner in apple	12
arborvitae	2
beech	4
birch (*Fenusa pumila*)	63
blueberry	1
boxwood	1
catalpa	31
chestnut	1
columbine	22
elm	16
grape	1
hydrangea	1
lilac	2
linden	2
locust	12
magnolia	1
maple	1
oak	8
peach	3
philadelphus	1
poplar	1
quince	1
sycamore	5
tulip tree	2
Leaf roller, spiræa	2
privet	1
Leaf tylers, sycamore	2
viburnum	1
Luna moth larvae	1
Melalopha inclusa	2
Midges on catalpa	1
Mites, European red	8
pear leaf blister	32
Mite galls on Cephalanthus	1
Exochorda	10
Mites on silver maple	16
birch	1
Delphinium	4
elm	2
juglans	1
juniper	1
linden	3
mountain ash	1
oak	5
spruce	8
willow	3
Oriental peach moth	48
Ormenis pruinosa	3
Papaipema larvae	2
Pear psylla	2
Pear slug	20
Sawfly larvae on arborvitae	3
birch	1
dogwood	4
mountain ash	1
pine	4
Scale, elm	21
oak gall	2
oyster-shell	78
pine leaf	13
rose	10
San José	22
scurfy	1
tulip tree	2
West Indian peach	5
Slug caterpillars	1
Sphinx larvae	1
Spiny elm caterpillars	1
Spittle bugs on arborvitae	1
forsythia	1
juniper	3
lilac	1
pine	1
weigelia	1
willow	1
Tussock moth eggs	2
Tussock moth larvae	2
Willow leaf beetle, *Plagiodera versicolora*	16
White flies	1
Yellow necked caterpillars	3
Zebra caterpillars	1

PLANT DISEASES

Name	No. nurseries
Anthracnose, cherry	9
currant	8
hollyhock	1
Anthracnose, poplar	5
sycamore	3
Bacterial leafspot, larkspur	46

Name	No. nurseries
Bacterial leafspot, peach	1
Black knot	6
Black rot, apple	24
Botrytus, paeony	16
Brown rot	
flowering almond	11
peach	2
plum	2
quince	1
Canker, poplar	37
Chestnut blight	1
Chlorosis silver maple	1
Crown gall	10
Entomosporium, quince	11
Exobasidium, honeysuckle	3
Symphoricarpos	2
Fire blight	1
Gnomonia ulmi	9
Leaf spot on Andromeda	8
Aristolochia	3
ash	2
Azalea	2
barberry	8
birch	1
box elder	5
boxwood	7
carya	1
catalpa	79
cherry	2
currant	1
dogwood	1
English ivy	2
grape	7
hollyhock	6
horse chestnut	34
iris	62
Japanese maple	55
juglans	1
kalmia	25
larkspur	1
lilac	2
mahonia	1
maple	57
mountain ash	21
oak	1
paeony	1
Leafspot on peach	1
phlox	74
quince	6
rhododendron	66
rhubarb	21
rose	98
strawberry	28
sycamore	1
yucca	2
Maple tar spot	16
Marsonia juglandis	10
Mildew on ampelopsis	1
apple	16
catalpa	30
golden glow	1
grape	5
Helianthus	1
juglans	1
larkspur	8
lilac	34
mountain ash	1
oak	1
phlox	50
raspberry	1
rose	78
solidago	1
symphoricarpos	1
sycamore	1
Mosaic on apple	23
raspberry	7
Raspberry cane blight	2
Rust on apple	46
ash	5
Bechtel's crab	43
Crataegus	19
hollyhock	7
juniper	11
pear	2
quince	7
Scab on apple	57
pear	2
willow	1
White pine blister rust on pine	2
on Ribes	7
Yellowing of lilacs	20

An examination of the preceding list will show that among the insects, the spruce gall aphid, *Adelges abietis*, as was the case in the last two years, was found in more nurseries (85) than any other insect, followed by oyster-shell scale (78), woolly pine bark aphids (75), apple woolly aphids (64), birch leaf miner, *Fenusa pumila* (63), blue spruce gall aphid, *Gillettea cooleyi* (62), green apple aphid (55), Oriental peach moth (48), rhododendron lace

bugs (41), white pine weevil (37) pear leaf blister mite (32), catalpa leaf miners (31), fall webworm (26), aleyrodes (25), aphids on crataegus (23), columbine leaf miner (22), San José scale (22), elm scale (21), apple and thorn skeletonizer (20), pear slug (20), *Plagiodera versicolora* (16), mite galls on silver maple (16), pine leaf scale (13), aphids on mountain ash (12), juniper webworm (12), leaf hoppers on apple (12), leaf miners on apple (12), leaf miners on locust (12), elm cockscomb gall. (11), aphids on flowering crab-apple (10), mite galls on Exochorda (10), rose scale (10), woolly elm aphid (10).

Among the plant diseases found in nurseries in 1929, leaf spot of rose heads the list (98), followed by leaf spot of catalpa (79), mildew of rose (78), leaf spot of phlox (74), leaf spot of rhododendron (66), leaf spot of iris (62), apple scab (57), leaf spot of maple (57), leaf spot of Japanese maple (55), mildew of phlox (50), apple rust (46), bacterial leaf spot of larkspur (46), rust of Bechtel's crab (43), poplar canker (37), leaf spot of horse-chestnut (34), mildew of lilac (34), mildew of catalpa (30), leaf spot of strawberry (28), leaf spot of Kalmia (25), black rot of apple (24), mosaic of apple (23), leaf spot of mountain ash (21), leaf spot of rhubarb (21), yellowing of lilacs (20), tar spot of maple (16), mildew of apple (16), *Entomosporium* of quince (11), brown rot of flowering almond (11), rust of juniper (11), *Marsonia juglandis* (10), and crown gall (10).

NINE-YEAR RECORD OF CERTAIN NURSERY PESTS

	1921	1922	1923	1924	1925	1926	1927	1928	1929
Oyster-shell scale	36	44	42	44	38	39	45	57	78
San José scale	28	19	20	32	32	19	16	30	22
Spruce gall aphids[1]	31	21	28	40	27	42	82	120	147
White pine weevil	1	19	17	5	5	8	17	19	37
Apple and thorn skeletonizer		1	18	2	8	9	22	49	20
Poplar canker	21	31	34	25	34	32	39	35	37
Pine blister rust (on *Ribes*)	2	9	6	8	7	9	9	5	7
Nurseries uninfested	36	36	32	33	34	46	37	18	13
Number of nurseries	*94*	*101*	*106*	*116*	*151*	*162*	*191*	*228*	*266*

It should be understood that the figures in the preceding table are not strictly comparable because of the greater number of nurseries since the new law went into effect in 1925. Thus though the number of infested nurseries is greater, the actual percentage may be considerably less.

Number and Size of Nurseries

The number of nurseries in Connecticut has increased each year. The list for 1927 contained 191 names. The list for 1928 contains 228 names and for 1929, 266 names. Of the 266 separate nurseries in the state, a classification on account of size may be made as follows:

[1] Includes both *Adelges abietis* and *Gillettea cooleyi.*

Nurseries containing	50 acres or more	16
" "	between 10 and 50 acres	37
" "	" 5 and 10 "	29
" "	" 2 and 5 "	64
" "	1 acre or less	120
		266

In 1929, 288 nursery inspections were made. The list of nursery firms receiving certificates contains 266 names; 22 being

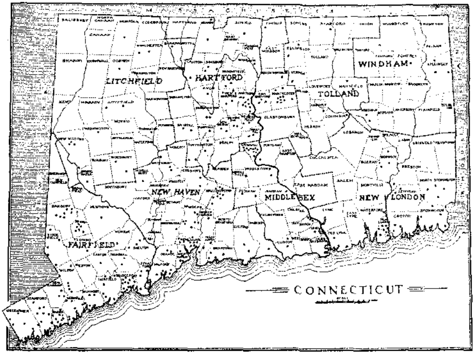

FIGURE 44. Map of Connecticut showing location of nurseries.

new nurseries registered in the winter that were inspected twice, once in the spring and again in the fall.

From the owners of three nurseries failing to register before July 1, as provided in Section 2, Chapter 265, Public Acts of 1925, $40 was collected to cover the cost of inspection, and this amount was sent to the State Treasurer on January 8, 1930. This cost of inspection would have been greater had it been necessary to make special trips from New Haven to inspect each nursery but when men are working in the vicinity of several nurseries the expense of travel is divided between the nurseries.

The total area of nurseries in Connecticut in 1929 is equivalent to about 3,157 acres. The figures were taken for the most part from the estimates of the owners and managers as given on the registration cards, supplemented by the inspector. Each nursery

of less than an acre in extent is listed as one acre and where fractions are given, the next whole number is recorded. Certified nurseries now number 266; 49 new ones have been added within the year, and 13 have discontinued the business. Sixteen on last year's list are now listed under different firm names. The location of these 266 nurseries is shown on the map in Figure 44. The list of nursery firms granted certificates in 1929 is as follows:

CONNECTICUT NURSERY FIRMS CERTIFIED IN 1929

Name of firm	Address	Acreage	Certificate issued	No. of certificate
Alius, Adolf	Stamford	1	Aug. 26	894
Aldrich, Miss Inie E.	Thomaston	5	Oct. 29	1,012
Allen, Henry L.	North Stonington	1	Aug. 5	831
Amato, John	Cromwell	1	Aug. 15	867
Amelunxen & DeWyn	Yalesville	4	July 31	802
Ampelopsis Nurseries	Groton	1	Aug. 5	828
Arawana Nurseries	Milford	1	Nov. 26	1,030
Artistree Nursery	*Branford*	*1*	*Oct. 24*	*1,005*
Austin, M. E.	Clinton	2	Sept. 21	971
Barnes Bros. Nursery Co.	Yalesville	150	Aug. 2	820
Barnes Eastern Nurseries	Wallingford	10	Aug. 1	819
Barnes Nursery & Orchard Co.	Wallingford	50	Oct. 22	1,003
Barrows, Paul M.	*Stamford*	*1*	*Nov. 23*	*1,028*
Barton, Robert	Hamden	1	Nov. 9	1,016
Beattie, W. H.	New Haven	1	Sept. 10	936
Benbow, A.	Norfolk	1	Sept. 24	972
Bertana, Louis	Glenbrook	2	Sept. 6	924
Bertolf Bros., Inc.	Greenwich	45	Aug. 14	863
Blake and Stuart	Preston	1	Aug. 5	825
Bonnie Brook Gardens	Rowayton	7	Aug. 20	881
Booy, H. W.	Yalesville	4	July 31	803
Botsford, R. C.	East Haven	1	Sept. 9	932
Brainard Nursery & Seed Co.	Thompsonville	15	Aug. 3	821
Braley, S. A.	Burnside	4	July 31	818
Branford Nurseries	Branford	4	Sept. 7	926
Brass, Fred W.	Andover	3	Aug. 5	823
Bretschneider, A.	*Danielson*	*1*	*Aug. 19*	*877*
Bridgeport Hydraulic Co.	Bridgeport	300	Nov. 12	1,017
Brimfield Gardens Nursery	Wethersfield	3	Aug. 28	906
Bristol Nurseries, Inc.	Bristol	50	Aug. 29	909
Brooklawn Conservatories, Inc.	Bridgeport	1	Nov. 26	1,031
Brooklawn Nursery	Bridgeport	2	Sept. 24	976
Brouwer & Hancock Nurseries	New London	20	Aug. 14	853
Brown, E. M.	Hartford and West Simsbury	2	Sept. 9	930
Bubenicek, Joseph	*Woodmont*	*1*	*Sept. 19*	*966*
Bulpitt, Henry F.	Darien	4	Aug. 7	839
Bunting's Nurseries, Inc.	Groton	10	Aug. 5	827
Burke, P. J.	Rockville	1	Aug. 14	851
Burr, Morris L.	Westport	1	Sept. 20	968

Name of firm	Address	Acreage	Certificate issued	No. of certificate
Burr & Co., Inc., C. R.	Manchester, Ellington and Durham	400	Aug. 7	836
Burwell, E. E.	New Haven	1	Nov. 23	1,020
Byram Evergreen Nursery	East Portchester	1	Aug. 14	856
Calvanese, John	Southington	1	July 31	816
Candee, Hollis S.	Hartford	6	Sept. 25	977
Cant, Alexander	Springdale	1	Aug. 27	902
Cardarelli, Emilio J.	Cromwell	4	Sept. 6	923
Carey, Alice L.	Cheshire	1	July 31	807
Cascio, Peter J.	Hartford	1	Dec. 16	1,045
Case, Louis L.	Simsbury	1	Sept. 12	943
Chapman, C. B.	Groton	1	Sept. 10	934
Chippendale Nurseries, Inc.	Lyme	2	Aug. 16	873
Clark, Raymond H.	Milford	2	Dec. 31	1,057
Cleary, Arthur B. (2)	Bethel	1	Sept. 17	960
Clyne, George A.	Middlebury	4	Dec. 23	1,046
Conine Nursery Co.	Stratford	65	Aug. 12	846
Conn. Agr. College (Prof. S. P. Hollister)	Storrs	1	Aug. 15	868
Conn. Agr. Expt. Station (W. O. Filley, Forester)	New Haven, Hamden, Norwich, Simsbury, Storrs	5	Oct. 1	988
Conn. Forestry Nursery	Centerbrook	5	Aug. 16	869
Conn. Valley Nurseries	Manchester	5	Aug. 7	837
Cooper's	Nichols	1	Oct. 2	990
Corrigan, James J.	West Haven	1	Sept. 12	944
Couture, E. R. (2)	Westport	2	Oct. 16	1,002
Cragholme Nurseries, Inc.	Greenwich	10	Aug. 20	882
Cromie, G. A.	New Haven	5	Aug. 26	896
Culver, W. B. (2)	Suffield	1	July 31	810
Dallas, Inc., Alexander	Waterbury	2	Aug. 16	875
Darien Nursery	Darien	6	Aug. 12	849
Dawson, Wm. A.	Willimantic	2	Aug. 14	852
Daybreak Nurseries, Inc.	Westport	12	Nov. 29	1,035
DeMars, F. H.	Winsted	1	Oct. 26	1,009
Doebeli, Charles A. (2)	Bridgeport	1	Dec. 31	1,056
Dondi, Augusto	Hamden	1	Oct. 26	1,008
Dougherty's Nursery	Yalesville	1	July 31	805
Dowd, Inc., F. C. (2)	Madison	2	Dec. 31	1,050
Dunlap, D. S.	Cromwell	3	Aug. 15	865
Dunn, James F.	Stamford	3	Aug. 31	918
Eager, Edward M.	Bridgeport	1	Sept. 14	956
East Rock Nursery Co.	New Haven	1	Aug. 17	876
Eell's Sons	Manchester	1	Dec. 10	1,043
Elfgren & Sons, I. P.	East Killingly	2	Aug. 23	888
Elm City Nursery Co., Woodmont Nurseries, Inc.	New Haven and Woodmont	150	Sept. 17	958
Elmgren, C. J.	Cromwell	1	Aug. 30	916

Name of firm	Address	Acreage	Certificate issued	No. of certificate
Elm Grove Cemetery Assn.	Mystic	1	Nov. 23	1,022
Evergreen Nursery Co.	Wilton	16	Aug. 6	833
Eyberse, John (2)	Norwich	1	Aug. 29	911
Fairty, C. H.	New Canaan	1	Oct. 26	1,006
Farmington Valley Nursery	Avon	3	Aug. 26	892
Flower City Rose Co.	Manchester	20	Aug. 7	838
Fraser's Nurseries & Dahlia Gardens	Willimantic	3	Aug. 24	891
Galligan, C. W. (2)	Orange and North Haven	2	Sept. 9	929
Gallup, Amos M. (2)	Stonington	1	Aug. 5	829
Gardner's Nurseries	Rocky Hill	100	Sept. 7	925
Geduldig's Greenhouses	Norwich	3	Sept. 9	931
Gilbert, Henry G.	Danielson	2	Nov. 25	1,024
Giuliano, John S.	Wethersfield	1	Sept. 18	962
Glastonbury Gardens	Glastonbury	1	June 12	795
Glen Terrace Nurseries	Hamden	35	Nov. 12	1,018
Godfrey's Stratfield Nurseries	Bridgeport	25	Dec. 31	1,052
Golden Hill Nursery	Shelton	2	Oct. 22	1,004
Goodwin Nurseries	Bloomfield	7	Aug. 16	874
Grillo, Nicholas	Milldale	1	July 31	815
Haas, E	Devon	1	Dec. 2	1,039
Hall, Henry A. L. (2)	West Haven	1	Sept. 10	937
Hamden Nurseries	Hamden	1	Sept. 7	927
Hansen, Peter	Fairfield	5	Oct. 8	993
Hartford Board of Water Commissioners (2)	Hartford	25	Oct. 1	987
Hawes, Frank M.	West Hartford	1	Aug. 22	884
Hearn, Thomas H.	Washington	1	Nov. 27	1,034
Heath and Co.	Manchester	10	July 26	797
Henninger, Christ	New Britain	1	Sept. 19	965
Hilliard, H. J.	Sound View	1	July 31	809
Hinckley Hill Nursery	Stonington	2	Aug. 14	859
Hiti Nurseries	Pomfret Center	10	Aug. 14	858
Holcomb, H. Parks	Winsted	2	Oct. 11	999
Holcomb, Irving	Simsbury	1	July 29	799
Holbridge, S. E.	Ledyard	4	Aug. 5	824
Hopeville Gardens	Waterbury	3	Nov. 23	1,025
Horan, James F.	Hartford	3	Dec. 31	1,049
Horan and Son, James	Bridgeport	1	Nov. 30	1,038
Houston, Byron D.	Mansfield	15	Nov. 2	1,013
Hoyt, Charles E.	Danbury	2	Sept. 11	941
Hoyt's Sons Co., Inc., Stephen	New Canaan	300	Aug. 30	914
Hunt and Co., W. W.	Hartford	8	Aug. 28	907
Innes, William	Milford	2	Aug. 27	904
Intravaia & Sons, J.	Middletown	1	Aug. 16	872
Jennings, G. S.	Southport	1	Dec. 31	1,060
Johnson, Tom	Bridgeport	1	Sept. 14	954
Judd, T. H.	Danbury	1	Dec. 31	1,053

Name of firm	Address	Acreage	Certificate issued	No. of certificate
Kelley & Son, James J.	Darien	7	Aug. 28	908
Keystone Nurseries	Danbury	1	Oct. 1	989
Kuen, Rudolph J. (2)	Foxon, East Haven	1	Sept. 9	933
Langstroth Conifer Nursery	Danbury	4	Sept. 11	940
Leghorn, John J.	Cromwell	17	Aug. 15	864
Lewis & Valentine, Inc.	Darien	9	Aug. 27	905
Liljenstein, Carl	New London	1	Aug. 5	826
Lundberg, E. A.	Darien	1	Aug. 26	893
Lynch, Mrs. J. H. (2)	Ridgefield	5	Aug. 14	855
Mallett, Geo. A.	Bridgeport	15	Sept. 13	948
Maplewood Nursery Co.	Norwich	3	Dec. 3	1,040
Marigold Farm	New Canaan	15	Oct. 9	994
Mason, Warren S.	Farmington	1	Aug. 14	861
Mather, S. T.	Darien	1	Nov. 27	1,033
McCarthy, John P. (2)	Danbury	1	Sept. 11	939
McConville, John	Manchester	1	Aug. 14	857
Meachen, Geo. C.[1]	Stratford	1	Sept. 19	967
Meier, A. R.	West Hartford	1	Nov. 23	1,021
Merwin Lane Nursery	East Norwalk	4	Sept. 13	947
Meyer, Carl H. H. (2)	Riverside	10	Aug. 14	860
Meyer, Ludwig	Bridgeport	5	Oct. 7	991
Middeleer, Inc.	Darien	20	Aug. 29	910
Millane Nurseries	Cromwell and Deep River	30	Aug. 31	919
Mill River Nursery	Fairfield	6	Sept. 18	964
Minge, G. H.	Rocky Hill	1	Sept. 24	973
Moraio Bros	Stamford	10	Aug. 27	900
Morgan, Wm. F. (2)	North Stonington	3	Aug. 30	915
Mount Carmel Nursery	Mount Carmel	1	Aug. 27	903
Newell, Raymond E.	West Hartford	1	Aug. 9	841
New Britain Board of Water Commissioners	New Britain	50	Oct. 1	986
New Haven Park Commission	New Haven	16	Aug. 12	847
New London Cemetery Association	New London	1	Sept. 5	920
New London County Nurseries	New London	9	Oct. 16	1,001
New York, New Haven & Hartford Railroad Co. (C. A. Haggerty)	Stamford	5	Sept. 17	959
Nicolson & Thurston	Litchfield	1	Sept. 13	949
North-Eastern Forestry Co.	Cheshire	60	July 26	796
Norwood Nursery	Hamden	1	Aug. 30	912
Oakland Nurseries	Manchester	5	July 26	798
Oakwood Novelty Gardens	East Hartford	1	Aug. 9	840
Old Orchard Nursery	Norwalk	2	Nov. 29	1,036
Ostergren, Herbert	Cromwell	2	July 31	806
Outpost Nurseries	Ridgefield	100	Aug. 14	862
Ouwerkerk, D. K.	Yalesville	10	July 31	804

[1] Deceased.

Name of firm	Address	Acreage	Certificate issued	No. of certificate
Palinkas Nursery (2) ...	South Norwalk	1	July 31	813
Park Gardens	Bridgeport	1	Dec. 31	1,051
Patterson, John	Old Saybrook	3	Aug. 23	887
Pedersen, Anthon	Stamford	2	Nov. 6	1,014
Pedone & Co., Ludovico..	Goshen	3	Sept. 14	952
Pequod Nursery Co.	Yalesville	15	Sept. 14	951
Peschko, Robert	Danbury	1	Sept. 11	942
Pestretto, Frank	West Hartford	1	Dec. 31	1,055
Pestretto, Salvatore	Hartford	1	Sept. 28	983
Pflomm, Charles W. (2).	Bridgeport	1	Sept. 24	975
Phelps & V. T. Hammer Co., J. W.	Branford	3	Dec. 26	1,047
Phillips, Alice G.	Milton	1	Sept. 13	950
Pierson, Inc., A. N.	Cromwell	150	July 31	800
Pinatello, M.	East Hartford	2	Aug. 27	898
Pinchbeck Bros., Inc.	Ridgefield	5	Aug. 22	883
Polish Orphanage Farm..	New Britain	1	Oct. 8	992
Pomeroy Blue Spruce Gardens	New Milford	5	Aug. 12	843
Pratt, Jr., George D.	Bridgewater	1	Oct. 26	1,007
Prospect Nurseries, Inc...	Cromwell	12	Aug. 15	866
Prudence Seymour Gardens	New Milford	1	Aug. 12	844
Rabinak, Louis	Deep River	2	Aug. 16	870
Rengerman, A. B.	Granby	1	Aug. 23	890
Reynolds, Stephen	South Norwalk	1	July 31	812
Richards, Warren	Clinton	10	Oct. 10	996
Richmond, Gordon L. ...	New Milford	3	Aug. 12	842
Rockfall Nursery Co.	Rockfall	90	Aug. 27	901
Rose Hill Nursery (2) ..	Gildersleeve	1	Nov. 7	1,015
Rottenberg, Julius	Newington	1	Aug. 20	880
Russell, Charles B.	Newington	1	Aug. 6	834
Sage, Hollister	Woodbury	1	July 31	817
Sasco Hill Evergreen Nursery	Southport	1	Sept. 14	955
Saxe-Floto	Waterbury	2	Aug. 14	850
Scarano, Alphonso	Groton	1	Oct. 29	1,011
Schaeffer Bros.	Norwich	4	Nov. 23	1,027
Schneider, Godfrey	West Haven	1	Sept. 12	945
Schulze, Charles T.	Bethel	2	Dec. 3	1,041
Scott's Nurseries	Bloomfield	5	Dec. 12	1,044
Seltsam's Pequonnock Gardens	Bridgeport	1	Sept. 28	980
Seymour, Fred R.	Riverton	1	Sept. 28	979
Shailer, Edwin E.	Haddam	1	Aug. 16	871
Sierman, C. H.	Hartford	8	Sept. 26	978
Silvermine Nurseries ...	Norwalk	1	July 31	811
Simonsen, H. C.	Plainville	2	Nov. 26	1,032
Snelgrove, S. J.	Windsor	1	Aug. 6	835
Soltes, Martin J.	Shelton	1	Sept. 18	963
Southport Nurseries	Southport	32	Aug. 12	845
South Wilton Nurseries..	Wilton	5	Aug. 30	917
Spencer, W. L. L.	Columbia	1	Aug. 5	822
Spring Nurseries	Forestville	1	July 31	814
Stack, Garrett M. (2) ...	Guilford	1	Sept. 21	969

Name of firm	Address	Acreage	Certificate issued	No. of certificate
Stack, Thomas M. (2)	New Milford	1	Sept. 28	982
Stafford Conservatories	Stafford Springs	1	Sept. 17	957
Stannard, E. H.	Wilton, Woodbury and Southbury	1	Sept. 28	981
State Highway Department (Landscape Division)	Ellington, Putnam, Wethersfield and Wilton	6	Oct. 11	998
State of Conn. (A. F. Hawes, State Forester)	Simsbury, Hartford	5	Aug. 23	889
State Street Nursery	New Haven	2	Aug. 14	854
Steck, Jr., C. A.	Bethel	2	Nov. 23	1,019
Steck, Charles A.	Newtown	10	Dec. 31	1,058
Steck, Nurseries, Inc.	Farmington	10	Dec. 31	1,059
Steck, Sarah B.	Bethel	1	Sept. 30	985
Stolle, J. W.	Bethel	1	Sept. 11	938
Stratford Rose Nurseries	Stratford	2	Sept. 14	953
Sunridge Nurseries (2)	Greenwich	10	Aug. 22	885
Sylvan Avenue Greenhouse	Bridgeport	2	Nov. 23	1,029
Tanner, Edward G.	Manchester	1	Aug. 27	899
Thomas & Sons, Inc., W. D.	Hamden	2	Dec. 31	1,048
Torizzo, P. A.	West Hartford	1	Nov. 23	1,023
Tree Farms, Inc.	Cromwell	15	Sept. 2	946
Tryon, George W.	North Stonington	1	Aug. 5	832
Upson, R. E.	Marion	2	Sept. 5	921
Van der Bom, F.	Bethel	5	Sept. 17	961
Vanderbrook & Son, C. L.	Manchester	30	Aug. 12	848
Vanderstam, C. L.	Yalesville	2	July 31	801
Van Wilgen Nurseries	Branford	10	Oct. 15	1,000
Vasileff, Nicholas	Greenwich	4	Nov. 23	1,026
Verkade's Nurseries	New London	50	Oct. 29	1,010
Vernik Nursery, John	Bridgeport	2	Sept. 24	974
Wallace Nursery	Wallingford	8	July 31	808
Wegner, C. F.	Noroton Heights	1	Oct. 9	995
Weirether, Leo	West Haven	1	Aug. 22	886
Westville Nurseries	New Haven	1	Dec. 31	1,054
Wheeler, C. B.	Stonington	1	Aug. 5	830
Wilcox, Elmer E.	Guilford	1	Sept. 21	970
Wild, Henry	Greenwich	2	Aug. 19	878
Wild, Henry	Norwalk	30	Aug. 19	879
Williams, Harry G.	Shelton	1	Sept. 28	984
Wilridge Nurseries (2)	Branchville	2	Aug. 30	913
Wilson & Co., C. E.	Manchester	100	Sept. 6	922
Wilson, Robert L.	Stamford	1	Aug. 26	895
Woodbridge Nursery Co.	New Haven	6	Oct. 10	998
Woodruff, C. V.	Orange	1	Sept. 7	928
Wyllie, David	Whitneyville	1	Dec. 7	1,042
Yale Forest School Nursery	New Haven	2	Sept. 10	935

Name of firm	Address	Acreage	Certificate issued	No. of certificate
Yale University Landscape Dept.	New Haven	11	Aug. 26	897
Zack Co., H. J.	Deep River	15	Nov. 30	1,037
Total acres		3,157		

Inspection of Raspberry Plantations

Only one firm applied in 1929 for the special inspection and certification of raspberry plants on account of the mosaic and allied diseases in order to meet the requirements of Michigan, Minnesota, New York, Vermont and Wisconsin. The inspections were made and a certificate issued to cover only the varieties indicated, as follows:

Special Certificate on Raspberry Plants

Name of firm	Address	Varieties	Certificate: Date of issue	Certificate: Number
Conine Nursery Co.	Stratford	Latham LaFrance Saint Regis	Oct. 15	19

Registration of Nursery Dealers

Chapter 265, Public Acts of 1925, provides that dealers in nursery stock must register each year, on or before March 1, with the State Entomologist, and cite the principal sources of their nursery stock. All dealers' permits are for the remainder of the calendar year and expire on December 31. During the year 104 such dealers have registered and received permits. The list of dealers is on file in the office of the State Entomologist, but is not printed in this Report.

Registration of Out-of-State Nurserymen

Nurserymen in other states wishing to ship stock into Connecticut are required to file with the State Entomologist signed copies of their nursery inspection certificates and make application for permits to ship stock into the state. These permits are valid only for the periods covered by the certificates placed on file. During the year 258 permits were issued to nurserymen in other states, but the list of firms receiving them is not printed in this Report.

Parcel Certificates

In addition to the regular inspection and certification of nursery stock, occasionally individuals wish to send shrubs and plants to their friends, and sometimes nurserymen need to ship packages

before receiving their regular certificates. Consequently 352 separate parcels of nursery stock were inspected and package certificates furnished.

Inspection of Narcissus Bulbs

On account of Federal Quarantine No. 62, narcissus bulbs grown in Connecticut cannot be shipped into other states unless given two inspections, one in the field in May, and the other after the bulbs have been dug for shipment. In case they are found to be infested with bulb flies or eelworms, they must then be treated. During the year 22,000 such bulbs were inspected and certified.

Inspection of Laurel and Decorative Materials

Considerable decorative material is gathered each year in Connecticut woodlands and shipped into New York City. This is mostly mountain laurel, *Kalmia latifolia*. If gathered within the gipsy moth quarantined area, it is examined by Federal inspectors, and if found clean, is certified for shipment. Much of it is collected outside the quarantined area and yet cannot enter New York without being certified. During the year 42 such certificates were issued.

Inspection of Shelled Seed Corn

On account of the European corn borer having been found in a portion of Connecticut, certain states would not allow shelled sweet corn for seed to enter unless it had been inspected and certified to be free from bits of cob large enough to carry borers. Therefore a large quantity of such seed corn was inspected as it came through the cleaning mill, and 1084 certificate tags were issued covering shelled corn and certain other seeds.

Blister Rust Control Area Permits

In 1929, nine blister rust control areas were legally established in Connecticut. Under such conditions, the Federal regulations require that before any shipments of currants, gooseberries or other species of *Ribes* or white pine or other five-leaf pines are shipped into the state, the shipper must apply to the State Entomologist for a permit. The shipper must give name and address of both consignor and consignee, name and number of plants of each species and variety to be shipped. If the shipment is to be sent to a point outside the control areas and does not contain any prohibited plants, the permit is granted. During the year 334 such permits have been issued. Black currants are now debarred by statute. The text of the law follows:

PUBLIC ACTS OF 1929

CHAPTER 172

AN ACT PROHIBITING THE GROWING OF BLACK CURRANT PLANTS

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. Any person who shall grow, plant, propagate, cultivate, sell, transport or possess any plant, root or cutting of the European black currant, or *Ribes nigrum*, shall be fined not less than five dollars nor more than twenty-five dollars.

SEC. 2. The director of the Connecticut Agricultural Experiment Station is authorized to seize and destroy any plants, roots or cuttings of said European black currant found in the State.

Approved June 3, 1929.

INSPECTION OF IMPORTED NURSERY STOCK

W. E. Britton and M. P. Zappe

Since 1920, the only nursery stock permitted to enter Connecticut directly from foreign countries has been fruit tree seedlings and rose stocks for propagation. This material enters the United States under a Federal system of notices and permits and is released at ports of entry, to be inspected by state inspectors at destination points. All other plant material brought into the country must go to Washington, where it is examined, and where it may be detained, fumigated or destroyed, if there is any question of infestation. All proper precautions are taken by the Plant Quarantine and Control Administration before allowing the plants to be distributed.

The imported nursery stock entering Connecticut in 1928-1929 was inspected at destination by Mr. Zappe, assisted at rush periods by Mr. Johnson, Mr. McFarland and Dr. Friend. They inspected fewer shipments and a smaller number of plants than last year, as the following table shows:

Year	No. of shipments	No. of cases	No. of plants
1920	17	87	814,491
1921	21	126	1,228,560
1922	30	159	1,997,595
1923	35	179	1,981,895
1924	33	313	3,489,170
1925	27	277	2,977,346
1926	32	347	3,443,357
1927	31	321	3,229,915
1928	26	277	2,680,700
1929	23	225	2,022,475

Sources of Imported Nursery Stock, 1928-1929

The greatest number of shipments and plants came from Holland, as in some of the preceding years. The following table shows the sources of this stock:

Country	No. of shipments	No. of cases	No. of plants
Holland	14	137	1,015,475
France	7	85	989,000
England	2	3	18,000
Total	23	225	2,022,475

These 23 shipments were imported by 10 different Connecticut firms, two of which imported 191 of the 225 cases containing 1,800,075 plants. Of the whole number of shipments, 14 contained only rose stocks, six were only fruit stocks and three contained both rose and fruit stocks.

Of this plant material inspected, 1,128,575 plants, or about 55 per cent, were rose stocks and the remainder, 893,000 plants, or about 45 per cent, were fruit seedlings, the quantity of each different variety being shown in the following table:

KINDS OF STOCK IMPORTED

ROSE STOCKS		
Rosa manetti	998,575	
Rosa rugosa	130,000	
		1,128,575
FRUIT STOCKS		
Apple (all kinds)	290,800	
Cherry (all kinds)	391,600	
Pear	151,500	
Plum	50,000	
Quince	10,000	
		893,900
Total		2,022,475

Time of Arrival and Inspection

This imported nursery stock begins to arrive in the late fall and continues into the winter. Some importers desire an immediate inspection, but others place the stock in storage and ask to have it inspected a little each week as they can use it in grafting and propagating. The following table shows the quantities of stock as inspected by months:

Month	No. of shipments	No. of cases	No. of plants
November	1	2	15,000
December	4	27	231,500
January	9	114	1,212,000
February	5	77	524,575
March	3	4	29,500
April	1	1	9,900
Total	23	225	2,022,475

The time required to inspect this stock is equivalent to one man working 21 days, and this time, together with traveling and other necessary expenses, amounts to nearly $400.

In addition to the material enumerated and tabulated above, there were 13 shipments of new varieties of plants and 28 shipments containing 685 pounds of tree seeds which were not inspected in Connecticut. The plants were inspected and the seeds fumigated with carbon disulfide at Washington, D. C. Reports of the 23 shipments inspected were sent to the Plant Quarantine and Control Administration, Washington, D. C.

Results of Inspection

Of the 23 shipments inspected, 12 shipments, or 52 per cent, were found free from infestation, but in the other 11 shipments, or 48 per cent, there were insects, small animals or plant diseases, some of which are well known pests. Details of these infestations are given below:

Infestations Intercepted on Imported Nursery Stock

11 Shipments Infested

INSECTS AND OTHER ANIMALS

Aporia crataegi Linn. Nests on apple (1 shipment), Andre Choplin, Maze, France.

Calophasia lunula Hubn. On pear (2 shipments), Andre Choplin, Maze, and A. Fermaud, Angers, France.

Emphytus cinctus Linn. On rose (8 shipments), Andre Choplin, Maze, A. Fermaud and Franco-American Seedling Co., Angers, France; W. C. Slocock, Woking, England; Felix & Dykhius, and Association Flora, Boskoop, Holland.

Lepidopterous pupa. On rose and pear (2 shipments), Andre Choplin, Maze, France; C. Klyn & Co., Boskoop, Holland.

Notolophus antiqua Linn. Rusty tussock moth eggs on cherry, apple and rose (3 shipments), Franco-American Seedling Co., Angers, France; F. J. Grootendorst and Association Flora, Boskoop, Holland.

Spiders Eggs. On rose and pear (2 shipments), Andre Choplin, Maze, and Franco-American Seedling Co., Angers, France.

Woolly aphid. On apple (1 shipment), A. Fermaud, Angers, France.

PLANT DISEASES

Crown Gall on Manetti rose (1 shipment), Association Flora, Boskoop, Holland.

INSPECTION OF APIARIES IN 1929

In 1929, as in former seasons, the apiaries of Connecticut were inspected by Mr. H. W. Coley, of Westport, and Mr. A. W. Yates, of Hartford, who have been paid for each day employed on this work. Mr. Coley covered the southern half of the state, Fairfield, New Haven, Middlesex and New London Counties, and Mr. Yates the northern half, Litchfield, Hartford, Tolland and Windham Counties.

The appropriation, now $4,000 for two years, has never been sufficient to cover the cost of inspecting all known apiaries in the state each year, so an attempt has been made to inspect some of them in alternate seasons in order to cover them all in each two-year period.

This inspection work in 1929 required 167 man days, and together with traveling expenses cost $2,169.10. In all 990 apiaries containing 9,559 colonies were inspected, in 1929, as against 852 apiaries containing 8,133 colonies in 1928. The apiaries averaged 9.55 colonies each in 1929 and 9.41 each in 1928.

The following table shows the number of apiaries and colonies inspected, the average number of colonies per apiary, and the average cost of inspecting each apiary and colony for each year since the inspection started in 1910:

TWENTY-YEAR RECORD OF APIARY INSPECTION IN CONNECTICUT

Year	No. of apiaries	No. of colonies	Average No. colonies per apiary	Average Cost of inspection per apiary	per colony
1910	208	1,595	7.6	$2.40	.28
1911	162	1,571	9.7	1.99	.21
1912	153	1,431	9.3	1.96	.21
1913	189	1,500	7.9	1.63	.21
1914	463	3,882	8.38	1.62	.19
1915	494	4,241	8.58	1.51	.175
1916	467	3,898	8.34	1.61	.19
1917	473	4,506	9.52	1.58	.166
1918	395	3,047	7.8	1.97	.25
1919	723	6,070	11.2	2.45	.29
1920	762	4,797	6.5	2.565	.41
1921	751	6,972	9.2	2.638	.24
1922	797	8,007	10.04	2.60	.257
1923	725	6,802	9.38	2.55	.27
1924	953	8,929	9.4	2.42	.25
1925	766	8,257	10.7	2.45	.22
1926	814	7,923	9.7	2.35	.24
1927	803	8,133	10.1	2.37	.234
1928	852	8,023	9.41	2.12	.225
1929	990	9,559	9.55	2.19	.227

In 1929, apiaries were inspected in 141 towns as against 149 towns in 1928 and 135 towns in 1927. Inspections were made in 1929 in the following 11 towns not visited in 1928: New Haven County—Ansonia, Beacon Falls, West Haven; Middlesex County—Durham; Litchfield County—Barkhamsted, Warren; Windham County—Ashford, Chaplin, Eastford, Hampton, Thompson.

On the other hand, in the following 20 towns visited in 1928, no inspections were made in 1929: Fairfield County—New Fairfield, Sherman, Westport; New Haven County—Bethany, Milford, New Haven, Orange, Oxford, Southbury, Waterbury, Woodbridge; Middlesex County—Saybrook; New London County—Bozrah, New London, Preston, Sprague; Litchfield County—Bridgewater, New Milford, Roxbury; Tolland County—Tolland.

In the following eight towns no inspections were made in either 1928 or 1929: Fairfield County—Bridgeport, Monroe, Newtown, Shelton, Trumbull, Weston; New London County—Lisbon; Tolland County—Willington.

In 1929, one apiary was inspected in Warren where for several years it was believed that no bees were kept; at least, none had been discovered.

European Foul Brood

European foul brood is a disease of the young larvae in the comb caused by a bacterial germ known as *Bacillus pluton*. The cell contents often have the odor of fermentation, though they are not particularly offensive and are not gelatinous or ropy. This disease is usually more troublesome in early summer than at other seasons and requeening with Italian queens and uniting two or more weak colonies to make them strong are the usual methods of treatment.

Of the 990 apiaries and 9,559 colonies inspected in 1929, only two apiaries and three colonies were found infested with European foul brood. This is the lightest infestation of both apiaries and colonies found since the inspection work started in 1910, and amounts to .02 per cent of the apiaries and .003 per cent of the colonies.

The following table shows a complete record of percentages of European foul brood infestation in Connecticut since the inspections were started in 1910:

Record of European Foul Brood

Year	Percentage of infestation Apiaries	Colonies	Year	Percentage of infestation Apiaries	Colonies
1910	75.9	49.7	1920	4.3	1.5
1911	51.8	27.4	1921	3.91	1.26
1912	47.7	23.5	1922	4.14	.85
1913	44.4	24.5	1923	2.34	.36
1914	32.6	13.9	1924	1.78	.526
1915	26.1	10.3	1925	2.48	.507
1916	18.8	7.05	1926	3.19	.858
1917	16.7	4.86	1927	1.12	.282
1918	9.8	3.3	1928	1.05	.324
1919	6.6	1.2	1929	.02	.003

During the season of 1929, European foul brood was found only in two towns: Winchester in Litchfield County, and Coventry in Tolland County. No apiaries infested with this disease were found in Fairfield, New Haven, Middlesex, New London, Hartford, and Windham Counties.

American Foul Brood

American foul brood is likewise a disease of the larvae in the cells, but it occurs at a time when the larvae are nearly mature or more advanced in their development than does the European foul brood. American foul brood is also caused by a bacterial organism or germ known to science as *Bacillus larvae*. The symptoms appear after the cells have been sealed and often after the brood has pupated. The cells are shrunken and if opened the contents have a very offensive odor and a peculiar stringy or ropy consistency. The usual remedy is to shake the bees into clean hives, destroy the infected combs, and disinfect or destroy the old hives. The diseased combs may be sterilized by soaking them in an alcohol-formalin solution containing 20 per cent of formalin, but this treatment is not widely practiced.

Of the 990 apiaries and 9,559 colonies inspected in 1929, 46 apiaries and 115 colonies were infested with American foul brood. This infestation is equivalent to 4.64 per cent of the apiaries and 1.2 per cent of the colonies inspected in 1929. This record is slightly higher than that of 1928; in fact, it is the highest percentage of infestation of American foul brood ever found by the inspectors in any season in Connecticut.

The following table shows a complete record of American foul brood since the apiary inspection work was started in Connecticut in 1910:

RECORD OF AMERICAN FOUL BROOD

Year	Percentage of infestation Apiaries	Colonies	Year	Percentage of infestation Apiaries	Colonies
1910	0	0	1920	1.18	.25
1911	0	0	1921	2.5	.56
1912	0	0	1922	1.38	.27
1913	0	0	1923	.985	.323
1914	1.07	.7	1924	1.04	.22
1915	.8	.18	1925	3.26	.424
1916	1.07	.15	1926	1.72	.29
1917	.42	.17	1927	3.11	.70
1918	1.01	.32	1928	4.213	.98
1919	3	1.1	1929	4.64	1.2

In 1929, American foul brood was found in the following 24 towns: Fairfield County—Danbury, Fairfield, Greenwich, Ridgefield, Stamford, Wilton; New Haven County—Cheshire, Hamden, Middlebury, Naugatuck, North Haven, Prospect, Wallingford; Middlesex County—East Hampton, Essex, Middlefield; New London County—Stonington; Litchfield County—Plymouth, Watertown; Hartford County—Bristol, New Britain, West Hartford, Wethersfield; Tolland County—Ellington. This disease was not found in Windham County.

Sacbrood

Sacbrood or pickled brood is a disease that causes the larvae or brood to die at about the time that the cells are capped. They lie on their backs with heads turned upward. Though the body is swollen and the contents are watery, there is no ropiness. The entire cell contents may be removed intact as if enclosed in a sac.

The color, though variable, is often light yellowish brown with head nearly black.

The cause of this disease is thought to be a filterable virus, and the usual treatment is to unite the weak colonies to make strong ones. In rare cases where the entire apiary becomes diseased, all colonies should be supplied with new queens.

The following table shows the record of sacbrood in Connecticut since the inspection work began in 1910:

RECORD OF SACBROOD

Year	Percentage of infestation Apiaries	Colonies	Year	Percentage of infestation Apiaries	Colonies
1910	0	0	1920	1.18	.229
1911	....	.51	1921	1.06	.157
1912	....	Several	1922	1.37	.187
1913	....	2.8	1923	.53	.086
1914	2.59	.721	1924	1.78	.52
1915	2.02	.47	1925	3.39	.836
1916	.428	.051	1926	1.1	.138
1917	1.48	.199	1927	.03	.0036
1918	.253	.032	1928	.035	.087
1919	1.24	.19	1929	.001	.0006

This year sacbrood was found in Connecticut only in Wallingford in New Haven County.

Statistics of Inspection

The statistics of apiary inspection by towns and counties are given on the following pages, with summary on page 527.

INSPECTION OF APIARIES, 1929

Town	Apiaries		Colonies		Foul brood		
	Inspected	Diseased	Inspected	Diseased	American	European	Sacbrood
Fairfield County							
Bethel	2	0	28	0	0	0	0
Bridgeport	0	0	0	0	0	0	0
Brookfield	4	0	84	0	0	0	0
Danbury	7	2	62	8	8	0	0
Darien	2	0	45	0	0	0	0
Easton	2	0	86	0	0	0	0
Fairfield	8	2	86	5	5	0	0
Greenwich	9	3	74	8	8	0	0
Monroe	0	0	0	0	0	0	0
New Canaan	11	0	84	0	0	0	0
New Fairfield	0	0	0	0	0	0	0
Newtown	0	0	0	0	0	0	0
Norwalk	6	0	57	0	0	0	0
Redding	5	0	94	0	0	0	0
Ridgefield	7	3	54	9	9	0	0
Shelton	0	0	0	0	0	0	0
Sherman	0	0	0	0	0	0	0
Stamford	3	1	20	1	1	0	0
Stratford	1	0	2	0	0	0	0
Trumbull	0	0	0	0	0	0	0
Weston	0	0	0	0	0	0	0
Westport	0	0	0	0	0	0	0
Wilton[1]	7	1	121	3	3	0	0
	74	12	897	34	34	0	0

Town	Apiaries		Colonies		Foul brood		
	Inspected	Diseased	Inspected	Diseased	American	European	Sacbrood
New Haven County							
Ansonia	2	0	6	0	0	0	0
Beacon Falls	1	0	24	0	0	0	0
Bethany	0	0	0	0	0	0	0
Branford	2	0	21	0	0	0	0
Cheshire	11	3	78	10	10	0	0
Derby	2	0	9	0	0	0	0
East Haven	2	0	22	0	0	0	0
Guilford	3	0	50	0	0	0	0
Hamden	3	1	31	6	6	0	0
Madison	3	0	18	0	0	0	0
Meriden	11	0	159	0	0	0	0
Middlebury	6	3	91	6	6	0	0
Milford	0	0	0	0	0	0	0
Naugatuck	4	1	76	3	3	0	0
New Haven	0	0	0	0	0	0	0

[1] One colony inspected twice.

Town	Apiaries Inspected	Apiaries Diseased	Colonies Inspected	Colonies Diseased	Foul brood American	Foul brood European	Sacbrood
New Haven County—*Cont.*							
North Branford	1	0	30	0	0	0	0
North Haven.	1	1	2	1	1	0	0
Orange	0	0	0	0	0	0	0
Oxford	0	0	0	0	0	0	0
Prospect	4	1	39	1	1	0	0
Seymour	2	0	4	0	0	0	0
Southbury ...	0	0	0	0	0	0	0
Wallingford ..	18	5	163	14	8	0	6
Waterbury ..	0	0	0	0	0	0	0
West Haven..	4	0	47	0	0	0	0
Wolcott	4	0	12	0	0	0	0
Woodbridge ..	0	0	0	0	0	0	0
	84	15	882	41	35	0	6

Town	Apiaries Inspected	Apiaries Diseased	Colonies Inspected	Colonies Diseased	Foul brood American	Foul brood European	Sacbrood
Middlesex County							
Chester	10	0	60	0	0	0	0
Clinton	4	0	63	0	0	0	0
Cromwell	4	0	67	0	0	0	0
Durham	11	0	227	0	0	0	0
East Haddam	8	0	242	0	0	0	0
East Hampton	11	2	150	6	6	0	0
Essex	4	1	45	1	1	0	0
Haddam	3	0	50	0	0	0	0
Killingworth..	4	0	67	0	0	0	0
Middlefield ..	4	3	44	11	11	0	0
Middletown ..	6	0	98	0	0	0	0
Old Saybrook	5	0	64	0	0	0	0
Portland	9	0	89	0	0	0	0
Saybrook	0	0	0	0	0	0	0
Westbrook ..	1	0	4	0	0	0	0
	84	6	1,270	18	18	0	0

Town	Apiaries Inspected	Apiaries Diseased	Colonies Inspected	Colonies Diseased	Foul brood American	Foul brood European	Sacbrood
New London County							
Bozrah	0	0	0	0	0	0	0
Colchester ...	12	0	188	0	0	0	0
East Lyme ...	4	0	133	0	0	0	0
Franklin	3	0	95	0	0	0	0
Griswold	4	0	79	0	0	0	0
Groton	6	0	79	0	0	0	0
Lebanon	12	0	208	0	0	0	0
Ledyard	5	0	59	0	0	0	0
Lisbon	0	0	0	0	0	0	0
Lyme	1	0	14	0	0	0	0
Montville	8	0	84	0	0	0	0
New London..	0	0	0	0	0	0	0
No. Stonington	1	0	54	0	0	0	0
Norwich	9	0	230	0	0	0	0
Old Lyme ...	1	0	14	0	0	0	0
Preston	0	0	0	0	0	0	0

Town	Apiaries		Colonies		Foul brood		Sacbrood
	Inspected	Diseased	Inspected	Diseased	American	European	
New London County—*Cont.*							
Salem	2	0	21	0	0	0	0
Sprague	0	0	0	0	0	0	0
Stonington	7	1	59	2	2	0	0
Voluntown	3	0	25	0	0	0	0
Waterford	3	0	24	0	0	0	0
	81	1	1,366	2	2	0	0

Town	Apiaries		Colonies		Foul brood		Sacbrood
	Inspected	Diseased	Inspected	Diseased	American	European	
Litchfield County							
Barkhamsted	6	0	23	0	0	0	0
Bethlehem	4	0	24	0	0	0	0
Bridgewater	0	0	0	0	0	0	0
Canaan	2	0	15	0	0	0	0
Colebrook	7	0	48	0	0	0	0
Cornwall	6	0	33	0	0	0	0
Goshen	4	0	43	0	0	0	0
Harwinton	6	0	22	0	0	0	0
Kent	7	0	122	0	0	0	0
Litchfield	14	0	155	0	0	0	0
Morris	3	0	22	0	0	0	0
New Hartford	12	0	51	0	0	0	0
New Milford	0	0	0	0	0	0	0
Norfolk	5	0	24	0	0	0	0
North Canaan	6	0	91	0	0	0	0
Plymouth	6	2	38	2	2	0	0
Roxbury	0	0	0	0	0	0	0
Salisbury	6	0	79	0	0	0	0
Sharon[1]	9	1	175	1	0	0	0
Thomaston	16	0	74	0	0	0	0
Torrington	14	0	87	0	0	0	0
Warren	1	0	6	0	0	0	0
Washington	5	0	139	0	0	0	0
Watertown	16	1	112	1	1	0	0
Winchester	17	1	86	1	0	1	0
Woodbury	3	0	73	0	0	0	0
	175	5	1,542	5	3	1	0

Town	Apiaries		Colonies		Foul brood		Sacbrood
	Inspected	Diseased	Inspected	Diseased	American	European	
Hartford County							
Avon	13	0	72	0	0	0	0
Berlin	15	0	210	0	0	0	0
Bloomfield	9	0	247	0	0	0	0
Bristol	17	5	155	14	14	0	0
Burlington	9	0	47	0	0	0	0
Canton	9	0	74	0	0	0	0
East Granby	2	0	15	0	0	0	0
East Hartford	9	0	39	0	0	0	0
East Windsor	14	0	92	0	0	0	0
Enfield	7	0	46	0	0	0	0
Farmington	16	0	108	0	0	0	0

[1] One bee paralysis.

Town	Apiaries Inspected	Apiaries Diseased	Colonies Inspected	Colonies Diseased	Foul brood American	Foul brood European	Sacbrood
Hartford County—*Cont.*							
Glastonbury	15	0	131	0	0	0	0
Granby	11	0	108	0	0	0	0
Hartford	5	0	36	0	0	0	0
Hartland	3	0	110	0	0	0	0
Manchester	14	0	83	0	0	0	0
Marlborough	2	0	31	0	0	0	0
New Britain[1]	20	1	100	1	0	0	0
Newington	5	0	28	0	0	0	0
Plainville	13	0	41	0	0	0	0
Rocky Hill	4	0	46	0	0	0	0
Simsbury	10	0	52	0	0	0	0
Southington	13	0	73	0	0	0	0
South Windsor	7	0	52	0	0	0	0
Suffield	7	0	69	0	0	0	0
West Hartford	14	1	115	2	2	0	0
Wethersfield[1]	14	1	65	1	0	0	0
Windsor	16	0	125	0	0	0	0
Windsor Locks	4	0	14	0	0	0	0
	297	8	2,346	18	16	0	0

Town	Apiaries Inspected	Apiaries Diseased	Colonies Inspected	Colonies Diseased	Foul brood American	Foul brood European	Sacbrood
Tolland County							
Andover	4	0	9	0	0	0	0
Bolton	2	0	19	0	0	0	0
Columbia	6	0	34	0	0	0	0
Coventry	13	1	100	2	0	2	0
Ellington	17	3	85	7	7	0	0
Hebron	6	0	30	0	0	0	0
Mansfield	7	0	24	0	0	0	0
Somers	7	0	47	0	0	0	0
Stafford	9	0	45	0	0	0	0
Tolland	0	0	0	0	0	0	0
Union	1	0	7	0	0	0	0
Vernon	10	0	51	0	0	0	0
Willington	0	0	0	0	0	0	0
	82	4	451	9	7	2	0

Town	Apiaries Inspected	Apiaries Diseased	Colonies Inspected	Colonies Diseased	Foul brood American	Foul brood European	Sacbrood
Windham County							
Ashford	4	0	39	0	0	0	0
Brooklyn	6	0	214	0	0	0	0
Canterbury	3	0	25	0	0	0	0
Chaplin	3	0	15	0	0	0	0
Eastford	6	0	13	0	0	0	0
Hampton	6	0	30	0	0	0	0
Killingly	15	0	65	0	0	0	0
Plainfield	6	0	28	0	0	0	0
Pomfret	9	0	61	0	0	0	0
Putnam	4	0	26	0	0	0	0
Scotland	9	0	41	0	0	0	0
Sterling	4	0	8	0	0	0	0

[1] One bee paralysis.

Town	Apiaries Inspected	Apiaries Diseased	Colonies Inspected	Colonies Diseased	Foul brood American	Foul brood European	Sacbrood
Windham County—*Cont.*							
Thompson ...	6	0	39	0	0	0	0
Windham	17	0	94	0	0	0	0
Woodstock ..	15	0	117	0	0	0	0
	113	0	805	0	0	0	0

Summary

County	No. towns	Apiaries In-spected	Apiaries Dis-eased	Colonies In-spected	Colonies Dis-eased	Foul brood American	Foul brood European	Sacbrood
Fairfield ...	14	74	12	897	34	34	0	0
New Haven	19	84	15	882	41	35	0	6
Middlesex..	14	84	6	1,270	18	18	0	0
New London	16	81	1	1,366	2	2	0	0
Litchfield[1]..	23	175	5	1,542	5	3	1	0
Hartford[2] ..	30	297	3	2,346	18	16	0	0
Tolland ...	11	82	4	451	9	7	2	0
Windham ..	15	113	0	805	0	0	0	0
	142	990	51	9,559	127	115	3	6

	No. apiaries	No. colonies
Inspected	990	9,559
Infested with European foul brood	2	3
Per cent infested	.02	.003
Infested with American foul brood	46	115
Per cent infested	4.64	1.2
Infested with sacbrood	1	6
Infested with bee paralysis	3	3
Average number of colonies per apiary		9.55
Cost of inspection		$2,169.10
Average cost per apiary		$2.19
Average cost per colony		.227

Registration of Bees: New Legislation

Though the law requiring beekeepers to register with the town clerk of the town in which the bees are kept, was first enacted in 1919, there has never been anything like a complete registration of all apiaries. There have been few prosecutions for failing to register. In other words, the law has not been enforced.

The General Assembly of 1923 passed an amendment to this law requiring the town clerks to report to the State Entomologist in case bees had been registered as of October 1, and to send a list of such registrations on or before the next February 1. This law did not require them to report in case no bees were registered, and as many failed to report, it was difficult to ascertain whether they were complying with the law or violating it. Though notices were sent repeatedly in certain cases, the needed information could be obtained only by making a personal visit to the office of the town clerk, which is, of course, expensive.

[1] One bee paralysis.
[2] Two bee paralysis.

The General Assembly of 1929 further amended this law requiring town clerks to report to the State Entomologist on or before December 1, and the report does not depend upon registrations. They are supposed to report whether registrations have been made or not. The text of this amendment is as follows:

PUBLIC ACTS OF 1929

CHAPTER 50

AN ACT AMENDING AN ACT CONCERNING THE REGISTRATION OF THE OWNERS OF BEES

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Section two of chapter 174 of the public acts of 1919 as amended by chapter 129 of the public acts of 1923 is amended to read as follows: A record of such registration and of the name and place of residence of the registrant and the definite location in the town where bees are kept by him shall be kept in a separate book in the office of the town clerk, which record shall be accessible to the public. Each town clerk shall, on or before December first, report to the state entomologist whether or not any such owners have been registered by him, and file with said state entomologist a complete list of such registrations.

Approved April 10, 1929.

During 1929, 712 apiaries and 6,752 colonies were registered with the town clerks. This is slightly more than two-thirds the number of apiaries and colonies that were inspected during the season, and in 27 towns no inspections were made.

The number of apiaries and colonies in Connecticut has been a matter of speculation. In 1929, 990 apiaries and 9,559 colonies were inspected and 712 apiaries and 6,752 colonies were registered with the town clerks. After checking the lists carefully and deducting those counted twice, definite figures are obtained and shown in the following table:

1929	Apiaries	Colonies
Inspected	990	9,559
Registered but not inspected	396	2,787
Total	1,386	12,346

There were eight towns in which no bees were registered and 27 towns in which no bees were inspected. As there are probably a moderate number of apiaries which were neither registered nor inspected in 1929, it seems fair to assume that there are at least 15,000 colonies of bees in Connecticut.

The text of the registration law as it now stands on the statute books is as follows:

"SECTION 1. Every person owning one or more hives of bees shall, annually, on or before the first day of October, make application to the town clerk of the town in which such bees are kept, for the registration of such

bees, and such town clerk shall issue to such applicant a certificate of registration upon the payment of a recording fee of twenty-five cents, which certificate shall be in the form prescribed and upon blanks furnished by the commissioner of domestic animals and shall be recorded in the office of such town clerk.

SEC. 2. A record of such registration with the name and place of residence of the registrant and the definite location in the town where bees are kept by him shall be recorded in a separate book in the office of the town clerk, which record shall be accessible to the public. Each town clerk shall, on or before December first, report to the state entomologist whether or not any such owners have been registered by him, and file with said state entomologist a complete list of such registrations.

SEC. 3. Any owner of bees who shall fail to register as required by the provisions of this act shall be fined not more than five dollars."

GIPSY MOTH WORK IN CONNECTICUT IN 1929

John T. Ashworth and W. E. Britton

The work of suppressing the gipsy moth is conducted by the State Entomologist in coöperation with the Federal Plant Quaran-

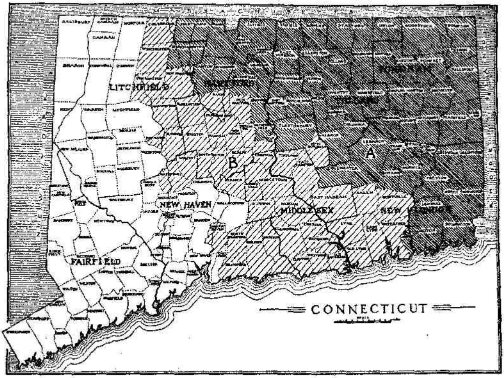

FIGURE 45. Map of Connecticut showing areas at present quarantined on account of the gipsy moth. A, generally infested; B, lightly infested.

tine and Control Administration. During the year, this work has been continued in the same manner as in former years and there have been no important or unusual developments. No extensive wind-spread has been discovered and no noticeable defoliation

such as has taken place in certain portions of Massachusetts, Maine and New Hampshire has occurred in Connecticut. There has been no change in the quarantine and the areas are the same as last year as shown in Figure 45. For the most part, the Federal forces have operated along the western border of the infested area in order to prevent further spread, and the state forces have covered the area further eastward where infestations are known to occur.

The appropriation is inadequate to provide for scouting in all infested towns each season; consequently, they are covered under the plan of a two-year rotation. No parasites were distributed in 1929.

We are greatly indebted to Mr. A. F. Burgess and Mr. H. L. Blaisdell in charge of the Federal Control work for their splendid coöperation, and we here express to them our appreciation and thanks.

Some scouting was done for the satin moth, which will be mentioned on another page of this report.

New Equipment

The only new equipment obtained during the season has been small tools and three new Ford light trucks to replace the three oldest ones.

Details of Work by Counties and Towns

A detailed account of the scouting, spraying and other control operations in the infested towns, is given on the following pages:

New London County

The work done in New London County this year was commenced near the end of the season and consisted of rapidly scouting around the old infestations. Following are the results of the work by towns:

North Stonington

Early in July, a crew was sent to North Stonington to look over the old infestations; 50 larvae were collected from different places in the town, but no heavy feeding was observed or reported.

Stonington

The same procedure was taken in regard to the town of Stonington, where 53 larvae were found. As in the case of North Stonington, no heavy feeding occurred, although larvae were picked up in several places in the village of Stonington.

Groton

25 Infestations 190 Egg-clusters

Twenty-two miles of roadside scouting was completed in Groton and 25 small colonies were discovered. The largest was one of 17 egg-clusters found on property owned by the Rev. G. Smith of Butler Court; a colony of 16 egg-clusters was found on apple and shade trees owned by Mr. M. Collins, on the New London-Mystic road; another small colony of 16 egg-clusters was discovered on three maple and one apple tree in West Mystic, on property owned by the Sea Sled Corporation. The other colonies ranged from one to 15 egg-clusters each. Seventeen of these colonies were sprayed by state men during the early part of June. In a check-up of these colonies after the spraying season, 132 larvae and pupae were found and killed.

New London

14 Infestations 490 Egg-clusters

Two large colonies of gipsy moth egg-clusters were found by state men while scouting New London this season; in fact, these two colonies contained 411 of a total of 490 egg-clusters found within the limits of the town. The largest was one of 327 egg-clusters in oak grove on estates owned by Messrs. Sackett and Rayburn, located on Glenwood Avenue. The other was one of 84 egg-clusters, at 67 Federal Street, on elm and maple trees owned by Mr. F. M. Butler. The other twelve colonies were all small, 17 egg-clusters being the largest. This colony was on pine and pear trees owned by Mr. J. Chamberlain at 69 Howard Street. Ten of these 14 colonies were sprayed by state men on June 6. Later in the summer men were sent to New London to check the results of spraying and a total of 283 larvae and pupae were found and destroyed.

East Lyme and Old Lyme

Work in these towns this year consisted of scouting around places that have been infested. A considerable territory outside of all the infestations was examined and no trace of the gipsy moth found in these towns.

Tolland County

Bolton

1 Infestation 1 Egg-cluster

Before Tolland County could be scouted this year, egg-clusters were hatching and larvae feeding; however, while waiting for the foliage to get out so that spraying would be effective, a crew was sent to last year's woodland infestation in Bolton on land owned by Mr. Samuel Alvord. Between seven and eight acres of wood-

land and three and a half miles of roadside were scouted around this colony. A total of 87 egg-clusters were discovered on 29 trees scattered throughout the woodland. This colony was sprayed on June 12 by state men, 6,400 gallons of liquid spray being used.

Stafford and Willington

The spraying of colonies discovered during the winter scouting was completed by June 20. It was thought advisable to scout for larvae in the towns of Stafford and Willington and to spray wherever the pest was found. This could be done to good advantage as the larvae had not at this time passed the heavy feeding stage; therefore, a crew was started in Willington on June 22. Three colonies were found and sprayed; then this crew moved to Stafford where they worked until June 29, using the same procedure as in Willington. Eleven colonies were discovered and sprayed. This was all the work that time, money, and men would permit in Tolland County this season. More work is planned to be done in this county next year.

Hartford County

Avon

1 Infestation 382 Egg-clusters

One large new infestation of 382 egg-clusters was found by the state men scouting Avon this season, in a pasture owned by Mr. W. R. Hodge on the west slope of Talcott Mountain. This colony is considered a very dangerous one, on account of the high elevation, as an easterly wind in the spring would spread the young larvae far westward. Approximately 11 acres of woodland were sprayed by state men about the middle of June.

Berlin

3 Infestations 163 Egg-clusters

One large colony of 154 egg-clusters was discovered in the northern end of the town near Webster Brook, extending from Berlin over the line into the southwest corner of Newington; 64 trees in mixed woodland were found to be infested and scattered over this area. This property is owned by Messrs. Sebastian and Furgerson of New Britain and Newington respectively. Another small colony was found in East Berlin on an apple tree in an orchard owned by Mr. George Dowd, where eight egg-clusters were found. The third infestation was a single egg-cluster on a roadside maple near the Stiles and Reynolds Brick Company property. The two first infestations were sprayed by state men between June 13 and June 17.

Burlington

2 Infestations 4 Egg-clusters

No new egg-clusters were found in this town this year. Three old egg-clusters were found at the 1926 infestation in the northwest corner of Burlington in woodland owned by Mr. Scheuster and another old egg-cluster was found on property owned by Mr. S. W. Coy near the Harwinton town line. No spraying was thought necessary and no further work was done in the town.

Canton

11 Infestations 323 Egg-clusters

State men started scouting in Canton on August 28 and stopped work in the town on September 18. The town was then turned over for use by the Federal men as a school for training new men. The scouting in Canton was completed by Federal forces. One large colony of 150 egg-clusters was found in woodland owned by Mr. Walter Freytag in the northern end of the town. The next largest was one of 88 egg-clusters and was found about a mile further south in pasture growth owned by Mr. Mike Bilitzke. The other nine colonies were small. Two colonies were sprayed by state men in the latter part of June.

East Granby

1 Infestation 80 Egg-clusters

One colony of 80 egg-clusters was found near the west border of the town about a mile north of Granby station. About 13 acres of woodland were sprayed at this colony between June 10 and 13 by state men.

Farmington

1 Infestation 15 Egg-clusters

A small woodland colony of 15 egg-clusters was found on property owned by the Hartford Gun Club in the northeastern corner of the town. About two acres of woodland were sprayed on June 15 by state men.

Granby

8 Infestations 115 Egg-clusters

The scouting in Granby this year consisted of scouting in the territory around last year's infestations. This was thought necessary, as the time for hatching was drawing very near and several towns were yet to be looked over. Eight infestations were found. The largest was one of 58 egg-clusters in pasture woodland margin owned by Mr. Andrew Boris of Canton, in the southwest corner of the town. Another of 15 egg-clusters also in pasture land, owned by Mr. Selden Hayes, about a mile east of the West Granby postoffice, was found. These two colonies were the largest found in the town this year.

Glastonbury

1 Infestation 11 Egg-clusters

In Glastonbury, as in Granby, the work consisted of scouting around the old infestations. One colony of 11 egg-clusters was found in one oak tree and a stone wall on land owned by Mr. John Scaroni, in the eastern end of the town near the Hebron town line. This colony was sprayed by state men on June 8.

Hartland

5 Infestations 24 Egg-clusters

In Hartland the work also was confined to the territory around last year's infestations. Five small infestations with a total of 24 egg-clusters were found. The largest was one of 10 egg-clusters in a stone wall and on a fence line in the state forest north of the East Hartland postoffice.

Hartford

2 Infestations 31 Egg-clusters

The largest of these two colonies was one of 20 egg-clusters found in maple and oak trees in the northeast corner of the city; the other was one of 11 egg-clusters found on a white oak tree in the rear of 50 Forest Street, owned by Prof. L. B. Paton. Both of these colonies were sprayed on June 13 by state men.

New Britain

5 Infestations 189 Egg-clusters

The old infestation on Bassett Street was found to be re-infested again this year; 139 egg-clusters were found on 26 trees in yards along this street. Another colony of 33 egg-clusters was discovered in a block of woodland owned by Mr. Peter Soring, in the western part of the town near the Plainville town line. Four of the five colonies were sprayed by state men on the 13th and 14th of June.

Newington

1 Infestation 1 Egg-cluster

One new egg-cluster was found in Newington this year in an apple orchard in the southwestern corner of the town. This is supposed to be a natural spread from the Berlin colony which, however, reached across the line into the town of Newington. No spraying was thought necessary in this case.

Simsbury

4 Infestations 134 Egg-clusters

While scouting around old infestations, state men found four infestations in Simsbury this year. One colony of 107 egg-clusters was found on apple and hickory trees in a pasture owned

by Mr. J. L. Brown just north of the West Simsbury postoffice, another of 14 egg-clusters on a white oak tree owned by the Ensign-Bickford Company about a mile south of the Simsbury postoffice, and a third colony of eight egg-clusters in woodland owned by the Ethel Walker School, were the three largest. These three colonies were later sprayed by state men.

Suffield

1 Infestation 4 Egg-clusters

The scouting in Suffield this year, as in several other towns in Hartford County, consisted of scouting around last year's infestations. This was necessary because of the fact that the scouting season was drawing to a close and we did not have the funds sufficient to carry enough men through the year to scout these towns completely. One colony of four egg-clusters was found in Suffield in elm and willow trees on land owned by Mr. Newton Lewis of Springfield, Mass., and Dr. J. A. Gibbs, of Suffield, Conn., about two miles north of West Suffield village.

Southington

1 Infestation 212 Egg-clusters

One large woodland colony of 212 egg-clusters was found on land owned by Mr. S. T. Gridley in the southeastern corner of Southington, about two miles from Milldale postoffice. Approximately four acres of woodland were sprayed at this colony by state men on June 3.

West Hartford

2 Infestations 486 Egg-clusters

Two large colonies were found in West Hartford by state men scouting the town. The largest was found in woodland owned by the Hartford Water Works on the east slope of Talcott Mountain. Here 375 egg-clusters were found on oak, maple, hemlock and walnut trees scattered over several acres. The other was a colony of 111 egg-clusters found on one willow tree, in the southern end of the town near the Newington line. Approximately 16 acres of woodland were sprayed about the middle of June by state men.

Wethersfield

1 Infestation 791 Egg-clusters

Last year a large colony was found in Wethersfield on the banks of the Connecticut River, but owing to weather conditions it was impossible to spray this colony. Again this year it was found infested, 791 egg-clusters being creosoted on poplar, willow and maple trees owned by Mr. E. Isaacson. About 10 acres of woodland were sprayed during the early part of June by state men.

In the towns of East Hartford and Manchester, work was confined for the most part to territory known to have been infested in previous years, but no trace of the gipsy moth was found in these towns. Other towns in Hartford County where scouting was completed and no infestations found were Bloomfield, Plainville and Rocky Hill.

Middlesex County

Cromwell

1 Infestation 47 Egg-clusters

A colony of 47 egg-clusters was found in Cromwell this season by state men. This colony was in apple and white oak trees in a pasture owned by Mr. Hoffman in the northwestern section of the town, and was sprayed on June 19, 2,200 gallons of spray mixture being used.

Middletown

1 Infestation 10 Egg-clusters

A colony of 10 egg-clusters was found on one maple and one pear tree in the yard on property owned by Mr. E. H. Longworth in the southern part of Middletown, near the Durham and Haddam line. This colony was sprayed on June 6 by state men.

Middlefield

1 Infestation 418 Egg-clusters

The Middlefield colony was found in woodland owned by Mr. C. E. Lyman on the east side of the railroad where it crosses the Durham town line. About five and one-half acres of woodland were sprayed at this place on June 5 by state men.

The towns of Chester, Durham, Essex, Saybrook and Westbrook were scouted in Middlesex County, and no traces of the gipsy moth were found in any of them.

New Haven County

Meriden

3 Infestations 36 Egg-clusters

A cluster of three small colonies was discovered by state men while scouting Meriden this season. They were situated in the central part of the town. One of 23 egg-clusters on Center Street was in cherry and plum trees on property owned by Mr. Jacob Rupenthal and Mr. Majesky, and the second was on Miller Street on roadside trees containing 12 egg-clusters. The third was a single egg-cluster found in a black oak tree on property owned by the Rev. G. L. Barnes, 26 Pleasant Street. Spraying was done in this town on June 4 by state men.

Wallingford

1 Infestation 298 Egg-clusters

Last year's colony in Wallingford was found to be re-infested again this year and 298 egg-clusters were found scattered over quite a large area of woodland in the northwestern corner of the town. About 108 acres of woodland were sprayed in this vicinity; about three and a quarter tons of arsenate of lead were used. All work in this town was done by Federal men.

Other towns in New Haven County where scouting was completed were Waterbury and Wolcott. State crews did the work in these towns; no trace of the gipsy moth was found.

Litchfield County

Barkhamsted

3 Infestations 119 Egg-clusters

While scouting Barkhamsted this season, state men discovered three colonies. One of 67 egg-clusters was found in maple and oak woodland owned by Mr. C. Le Geyt, near the Granby town line about two and one-half miles east of the Barkhamsted postoffice. The second was one of 30 egg-clusters found in oak and pine woodland owned by the Hartford Water Works, about one mile south of the Barkhamsted postoffice. The third colony was also in oak and pine woodland owned by Mr. H. P. Birden and situated near the postoffice. It contained 22 egg-clusters. All three infestations were sprayed in late June by state men.

Canaan

6 Infestations 312 Egg-clusters

One colony containing 274 egg-clusters was found in woodland owned by Mr. E. D. Tracy, on the western slope of Canaan Mountain near the North Canaan town line. The other five colonies were all small, the largest containing 22 egg-clusters found in woodland owned by Mr. A. W. Krouse, about one mile southeast of the colony mentioned above. The large colony was sprayed, both scouting and spraying being done by Federal men.

Colebrook

4 Infestations 33 Egg-clusters

The work in this town was done by state men. Four small colonies were found, all of them in pastures. Two of the colonies were in the northeastern corner of the town on property owned by the Pinehurst Lakes Company and Mr. Joseph Tilles, where 22 and eight egg-clusters, respectively, were found. Another infestation of two egg-clusters was discovered in the southwestern corner of the town in a stone pile on property owned by Mrs.

H. T. Matheson. The fourth infestation was a single egg-cluster found on a pasture apple tree owned by Mr. Gus Guest, in the southeastern corner of the town just north of the Robertsville postoffice. Spraying in this town was completed June 27.

Cornwall

4 Infestations 85 Egg-clusters

All work in Cornwall was done by Federal men. The four colonies found were on land owned by Dr. W. C. Clark. Three of these infestations were on Coltsfoot Mountain; the other was in the valley between South and Howland Mountains. About 26 acres of woodland were sprayed in the early part of June at these infestations.

Goshen

When Federal men were sent to the town of Goshen to scout, they found egg-clusters hatched and larvae crawling at the infestation found last year in the woodland owned by the Waterbury Water Company. This place was scouted for larvae, but no other work was done.

Harwinton

1 Infestation 2 Egg-clusters

A small infestation of two egg-clusters was found by the state men scouting Harwinton this season. It was in an apple orchard owned by Mr. David Mansfield, about one mile north of the Campville postoffice. As both egg-clusters were whole and were creosoted, no spraying was thought necessary at this place.

New Hartford

2 Infestations 108 Egg-clusters

Two colonies were discovered in the south central part of the town about two and one-half miles south of Nepaug village. The largest was one of 91 egg-clusters found in mixed growth woodland owned by Mr. R. Surdan. The other was one of 17 egg-clusters in apple and birch growth owned by Mr. J. Perry. About two acres of woodland were sprayed at Mr. Surdan's place and one-half acre at the other colony. All work done in this town was performed by state men.

Norfolk

10 Infestations 301 Egg-clusters

One large woodland colony was found in Norfolk on land owned by Mr. James Torrant, in the northwestern corner of the town. There were three other small colonies in the same section of the town within a radius of two miles. Another cluster of colonies was found in the northwestern corner of the town, the two largest

of which contained 21 egg-clusters each; one was an orchard infestation and the other woodland, both on property owned by Mr. F. H. Toros. About 20 acres of woodland were sprayed at three of these colonies, all work being done by Federal men.

North Canaan

5 Infestations 243 Egg-clusters

Two large colonies were found in North Canaan by a Federal crew this season. One of 191 egg-clusters was in a pasture owned by Mrs. E. B. Tracy, about two miles directly south of the Canaan postoffice. Another of 42 egg-clusters was found in woodland owned by Mr. Adam Noble in the southwestern corner of the town. The other three infestations were all small, containing altogether 11 egg-clusters. About 26 acres of woodland were sprayed at two of the infestations during the middle of June, scouting and spraying being done by Federal men.

Salisbury

4 Infestations 244 Egg-clusters

Federal men while scouting Salisbury this year found a cluster of three infestations in the northeastern corner of the town on the ridge composed of Miles and Toms Mountains; all three were woodland colonies and on land owned by Mr. J. C. Roraback. The largest colony contained 54 egg-clusters; the other two 48 and 35 egg-clusters each. The fourth was a colony of 107 egg-clusters in woodland owned by Mr. J. Barkett, about one and one-half miles west of Chapinville station. Approximately 277 acres of woodland were sprayed by Federal men.

Warren

3 Infestations 124 Egg-clusters

One woodland colony of 82 egg-clusters and an orchard colony of 12 egg-clusters were discovered about a mile east of Warren village on land owned by Marshepaug Forest Club, and a third colony of 30 egg-clusters was found in woodland owned by Warren Land Company in the northwestern corner of the town. These colonies were all found by Federal men while scouting the town of Warren this season. A Federal crew in June sprayed 72 acres of woodland and 30 of apple trees in and around these three colonies.

The following four towns were scouted by state men and no infestations found: Plymouth, Thomaston, Torrington and Winchester. Towns scouted by Federal men in Litchfield County with no infestations found were the following: Bethlehem, Bridgewater, Kent, Morris, New Milford, Roxbury, Sharon, Washington, Watertown and Woodbury.

Fairfield County

Fairfield

1 Infestation 1 Egg-cluster

All the work in Fairfield County was done by Federal scouts. Only one town was found to be infested, namely, Fairfield. One new egg-cluster was found in this town on a shade tree at 74 Roanoke Avenue on property owned by Mr. A. Sewell. No spraying was done, as it was not thought necessary.

The following towns in Fairfield County were scouted and no trace of the gipsy moth was found: Bethel, Bridgeport, Brookfield, Danbury, Darien, Easton, Greenwich, Monroe, New Fairfield, Newtown, New Canaan, Norwalk, Redding, Ridgefield, Shelton, Sherman, Stamford, Stratford, Trumbull, Weston, Westport and Wilton.

Statistics of these infestations are given in tabular form on the following pages:

STATISTICS OF INFESTATIONS, 1928-29

Towns	No. infestations found	No. egg clusters creosoted	No. colonies sprayed	No. lbs. poison used	No. larvae and pupae killed	No. miles roadway scouted
New London County						
North Stonington*	0	0	0	0	50	0
Stonington*	0	0	0	0	53	0
Groton	25	190	17	403	132	22
New London	14	490	10	417	283	13
East Lyme*	0	0	0	0	0	6
Old Lyme*	0	0	0	0	0	5
	39	680	27	820	518	46
Tolland County						
Stafford*	11	hatched	11	598	0	0
Willington*	3	"	3	250	0	8
Bolton*	1	"	1	400	0	3
	15		15	1,248	0	11
Middlesex County						
Cromwell	1	47	1	137	0	42
Middletown	1	10	1	20	10	130
Middlefield	1	418	1	180	12	36
Durham	0	0	0	0	0	27
Chester	0	0	0	0	0	38
Saybrook	0	0	0	0	0	36
Essex	0	0	0	0	0	33
Westbrook	0	0	0	0	0	36
	3	475	3	337	22	378

* Scouted around old infestations.
† Scouted by Federal men.

Towns	No. infestations found	No. egg clusters creosoted	No. colonies sprayed	No. lbs. poison used	No. larvae and pupae killed	No. miles roadway scouted
Hartford County						
Hartland*	5	24	0	0	42	12
Granby*	8	115	0	0	427	2
East Granby*	1	80	1	625	0	13 acres
Suffield*	1	4	0	0	0	3
Simsbury*	4	134	3	100	21	2
Canton†	11	323	2	125	152	68
Burlington	2	4	0	0	39	73
Avon	1	382	1	450	2	58
Farmington	1	15	1	75	20	116
West Hartford	2	486	1	775	90	93
Hartford	2	31	2	175	0	40
New Britain	5	189	4	231	25	39
Newington	1	1	0	0	0	27
Wethersfield	1	791	1	950	233	40
Bristol	0	0	0	0	0	62
Plainville	0	0	0	0	0	32
Southington	1	212	1	120	63	112
Berlin	3	163	2	712	39	77
Rocky Hill	0	0	0	0	0	46
Bloomfield	0	0	0	0	0	80
East Hartford*	0	0	0	0	0	12
Manchester	0	0	0	0	0	70
Glastonbury*	1	11	1	12	0	16
	50	2,965	20	4,350	1,153	1,080
New Haven County						
Wolcott	0	0	0	0	0	55
Waterbury	0	0	0	0	0	157
Wallingford†	1	298	1	6,600	0	131
Meriden	3	36	1	70	64	109
	4	334	2	6,670	64	452
Litchfield County						
Colebrook	4	33	1	25	34	70
Barkhamsted	3	119	3	1,025	299	60
Winchester	0	0	0	0	0	115
New Hartford	2	108	2	125	146	107
Torrington	0	0	0	0	0	127
Harwinton	1	2	0	0	0	86
Plymouth	0	0	0	0	0	74
Thomaston	0	0	0	0	0	56
Salisbury†	4	244	3	10,930	0	120
North Canaan†	5	243	2	987	0	56
Canaan†	6	312	1	100	0	67
Norfolk†	10	301	2	740	0	94
Goshen†	0	0	0	0	0	0
Cornwall†	4	85	2	1,335	0	107
Warren†	3	124	3	2,876	0	61
Sharon†	0	0	0	0	0	131
Kent†	0	0	0	0	0	100
New Milford†	0	0	0	0	0	180

Towns	No. infestations found	No. egg clusters creosoted	No. colonies sprayed	No. lbs. poison used	No. larvae and pupae killed	No. miles roadway scouted
Litchfield County—*Cont.*						
Bridgewater†	0	0	0	0	0	52
Roxbury†	0	0	0	0	0	71
Woodbury	0	0	0	0	0	104
Washington†	0	0	0	0	0	107
Morris†	0	0	0	0	0	47
Bethel†	0	0	0	0	0	53
Watertown†	0	0	0	0	0	93
	42	1,571	19	18,143	479	2,138
Fairfield County						
Sherman†	0	0	0	0	0	48
New Fairfield†	0	0	0	0	0	51
Brookfield†	0	0	0	0	0	61
Danbury†	0	0	0	0	0	99
Bethel†	0	0	0	0	0	53
Newtown†	0	0	0	0	0	187
Ridgefield†	0	0	0	0	0	97
Redding†	0	0	0	0	0	92
Monroe†	0	0	0	0	0	74
Wilton†	0	0	0	0	0	71
Weston†	0	0	0	0	0	49
Easton†	0	0	0	0	0	70
Trumbull†	0	0	0	0	0	59
Shelton†	0	0	0	0	0	105
Greenwich†	0	0	0	0	0	144
Stamford†	0	0	0	0	0	95
New Canaan†	0	0	0	0	0	72
Darien†	0	0	0	0	0	47
Norwalk†	0	0	0	0	0	144
Westport†	0	0	0	0	0	84
Fairfield†	1	1	0	0	0	175
Bridgeport†	0	0	0	0	0	201
Stratford†	0	0	0	0	0	80
	1	1	0	0	0	2,158

Summary of Statistics

County	No. towns covered	No. infestations found	No. egg clusters creosoted	No. colonies sprayed	No. lbs. poison used	No. larvae and pupae killed	No. miles roadway scouted
New London	6	39	680	27	820	518	46
Tolland	3	15	....	15	1,248	0	11
Middlesex	8	3	475	3	337	22	378
Hartford	23	50	2,965	20	4,350	1,153	1,080
New Haven	4	4	334	2	6,670	64	452
Litchfield	25	42	1,571	19	18,143	479	2,138
Fairfield	23	1	1	0	0	0	2,158
	92	154	6,026	86	31,568	2,236	6,263

Financial Statement

RECEIPTS

Appropriation for biennial period ending June 30, 1929	$100,000.00	
Rebate on automobile insurance	199.04	
	$100,199.04	
Expended, July 1, 1927, to June 30, 1928	53,043.39	
Balance available July 1, 1928		$47,155.65

EXPENDITURES

Salaries		$ 4,840.00	
Labor		34,938.85	
Stationery and office supplies		30.05	
Sundry supplies		11.31	
Communication service			
Telephone		67.55	
Travel expenses		355.99	
Gasoline		1,451.80	
Oil		476.37	
Express		1.90	
Heat, light, water and power:			
Fuel	$157.00		
Electricity	22.52		
		179.52	
Tools, machinery and appliances:			
Passenger-carrying vehicles, trucks	$1,786.00		
Other equipment	909.29		
Auto repairs	633.29		
Other equipment, repairs	19.50		
		3,348.08	
Buildings and land:			
Rent of office and storehouse and storage of cars		581.00	
Contingent expenses:			
Insurance	$553.87		
Medical services	39.50		
		593.37	
Spray materials		271.50	
			$47,147.29
Balance on hand June 30, 1929			$8.36

THE COST OF SPRAYING WOODLAND IN CONNECTICUT FOR THE CONTROL OF THE GIPSY MOTH

Roger B. Friend and Neely Turner

Woodland spraying for the control of the gipsy moth in New England has been carried on for about 30 years, and when trees can be thoroughly sprayed, the operation is highly successful. The spraying technique has been developed so that few areas are not accessible, and the high-powered pumps and solid stream

nozzles make possible the spraying of trees up to 75 feet in height at the end of a hose line 3,000 to 4,000 feet long. The degree of success attained and the cost of the work, however, depend on many factors that vary in different areas. Such factors are: the type of tree growth, the characteristics of the terrain, the extent of the infested area and its accessibility, the use of the land for grazing, and the availability of water. The woodland spraying in this state is done in an effort to prevent further spread of the insect, so many of the areas sprayed are small and isolated. In such instances, the extent of the area sprayed depends on the location of the egg masses found by the scouts.

Some estimates of the cost of spraying have been made in former years. Burgess, in 1910, stated that with the equipment then in use, one outfit and crew should be able to spray 12 acres a day at a cost of $10.00 an acre. Worthley, in 1917, estimated the cost at about five and one-half dollars an acre for large areas where it was not necessary to move the sprayer and re-lay the hose line, and stated that one crew should be able to spray 12 to 15 acres a day under average conditions, the maximum under favorable conditions with trees 60 to 70 feet tall being 21 acres. Inasmuch as the above estimates were made some years ago for areas outside of Connecticut, it was considered advisable to obtain data on the present cost per acre in this state, and to consider the various factors involved in this cost, for no two areas are exactly alike. The writers wish to emphasize the fact that extensive gipsy moth control work involves scouting, spraying, and other necessary operations, and that the work of spraying is confined to the early summer when the larvae are small and involves by no means a majority of the outlay of capital and labor.

Four infested areas in Connecticut have been studied in 1929, each of them differing from the others and each separated from the others by a distance of some miles. The first area studied is in the town of Southington; the second is in Wethersfield; the third in West Hartford; and the fourth in Avon. All were sprayed in June by the same crew of men and with the same equipment. In each case, data were obtained concerning the species of trees and shrubs present, their size, their abundance, and their distribution; the characteristics of the terrain, its slope, evenness, altitude above sea level, and the debris on the ground; the size and shape of the area, its accessibility, the availability of water; and the use of the land for grazing. The cost for each area has been estimated on the basis of actual spraying time, that is, from the time the crew begins to lay the hose until the work is finished and the hose taken up. Any delay caused by the breakdown of the sprayer or similar incident has been deducted from the time. Considerable time was consumed by traveling from one area to another and operations were held up by unavoidable diffi-

culties with the equipment. Time so used is omitted from the cost estimates, but has a bearing on this cost because it affects the total amount of actual spraying done in one season by the crew and equipment.

Equipment

Although Worthley (1917) has described the apparatus used in gipsy moth spraying, some changes have been made since the publication of his bulletin, so a brief description of equipment and supplies used in the 1929 operations is here given. For a detailed description of the pump, hose, and nozzles, the above author may be consulted.

1. *Sprayer*—A Waukesha truck (A22) with an engine rated at 90-110 horsepower, carrying a Fitzhenry-Guptill sprayer with a 400-gallon tank divided into two compartments each of 200 gallons capacity. Power for the sprayer is furnished by the truck motor. This outfit will deliver 1,000 pounds pressure at the pump and 250 pounds at the nozzle with a hose line half a mile or more long under most conditions. One compartment of the tank can be filled while the other is being emptied. Cost, $7,000 in 1918. The latest sprayer of this type is mounted on a lighter truck and may cost slightly less to operate. The machine used was loaned by the United States Bureau of Entomology, which coöperates with the state.

2. *Water pump*—A small portable one and one-half horsepower gasoline engine with a three-cylinder pump, made by the Fitzhenry-Guptil Company. This is used to pump water from a nearby source to the sprayer. Cost, $650 in 1926.

3. *Hose*—A heavy hose capable of withstanding the pressure and rough treatment to which it may be subjected. The couplings are of a special type, designed by the Federal Bureau of Entomology, that becomes tighter with increased pressure. This hose comes in 50-foot lengths and costs 75 cents a foot, couplings included. Twelve hundred and fifty feet are carried on the sprayer.

4. *Nozzle*—A "Worthley" nozzle which can be fitted with tips varying in inside diameter from one-eighth to five-sixteenths of an inch. The most commonly used nozzle for spraying tall trees has a one-fourth inch bore. For low trees, the smaller tips are used, but in any case the nozzle pressure should be maintained at 225 to 250 pounds for efficient work. Cost, $15.

5. *Accessory trucks*—Two Model T light Ford trucks were used to carry extra hose, small tools, supplies, and so forth. These trucks are used throughout the year for gipsy moth control work and no cost is estimated.

6. *Lead arsenate*—Powdered acid lead arsenate of commercial make. Cost, 12.75 cents a pound.

7. *Fish oil*—Pressed menhaden oil. Used in the spray mixture as a sticker.. Cost, 73 cents a gallon. This price was taken from the "Oil, Paint and Drug Reporter" for June 3, 1929, and is not the cost of the oil actually used.

8. *Gasoline*—Seventeen cents a gallon.
9. *Lubricating oil*—12.5 cents a quart.
10. *Crew*—1 general foreman
2 crew foremen
6 hosemen
1 nozzleman
1 mechanic and general assistant
1 truck driver

Total cost of crew per hour, $6.89.

The general foreman supervised three crews so that the cost per hour of this one man is one-third his salary. The depreciation on the sprayer, portable pump, hose, and nozzle are difficult to estimate because of the irregularity of the work, but a depreciation of 20 per cent per year on the sprayer and pump is usually charged. The depreciation on the nozzle is negligible and no charge is made for this item. Hose lasts about three years, and one-third of the cost of 3,500 feet has been charged to the 1929 season. Considering the depreciation in equipment and the fact that 96 hours of spraying were done in one year (1929), the depreciation per hour may be charged as follows:

Sprayer	$1.25
Water pump	.67
Hose	9.11
Total	*$11.03*

The truck undergoes considerable wear in traveling from one *area to another, but this has been charged to the spraying cost.* The determination of the extent of the area to be sprayed is accomplished by the scouting crew and does not enter into the cost of spraying.

Description of Areas

The primary purpose of the descriptions of the four areas sprayed is to show what kind of woodland was sprayed and what factors affect the cost of spraying, but it is of some interest to know the conditions under which the gipsy moth may become established and persist. Not only is information given, therefore, on those characteristics of site and tree growth previously mentioned (page 544) which directly bear on the cost of the spraying operation, but the brief history of the infestation from its dis-

covery to the spraying period of 1929 is included. The persistence and intensity of a gipsy moth infestation under natural conditions are largely dependent on the type of tree growth and the climate, and the presence of a relatively small number of trees, or of undergrowth and brush, on which the first two larval instars can develop, may enable this insect to become destructive over a considerable area of woodland in which the majority of economically important trees are not particularly favored as food plants. The suitability of the tree growth for the development of the gipsy moth has been determined according to the results of the work of Mosher (1915).

The areas were measured by pacing and the use of a small hand compass. In order to determine the type of growth in each area, sample plots were laid out at places suitable in size and location, and in these plots trees of one inch or more in diameter breast high were measured, counted, and listed according to species. The presence or absence of undergrowth and brush was noted. The various types of growth have been indicated on the maps of the areas. Because of the great dissimilarity in site and vegetation and the fact that on only one area, West Hartford, was there even an approximately uniform covering of trees, each infestation has been described separately. In Table 3 are the data on the number of species of trees occurring in each area. Although in the course of the investigations, all the trees were measured to the nearest half inch in diameter breast high, in the table the measurements are given in six-inch groups in order to condense the statistics. This gives as close an estimate of the relative size of the crown as can conveniently be made. In Tables 1 and 2 are given the items related to the cost of spraying and the estimated cost per acre.

1. Southington, Figure 46

The infestation in Southington comprises an area of eight acres, approximately 349,546 square feet, of fairly level land bordering the state highway about two and one-half miles south of the center of the town. The elevation drops gently from 180 feet above sea level on the south side to 160 feet on the north side. The ground is fairly wet, but not swampy, so that while spraying, the men frequently sank in water to their shoe-tops. A brook about 500 feet away furnished water. This area has been divided into seven parts, according to the types of vegetation.

(1) Four-tenths of an acre, about 18,135 square feet, rectangular in shape, on the east side of the area. Sample plot III.

All the trees in this area were tabulated. The predominant tree was swamp white oak, with American elm, red cedar, and gray birch in smaller numbers, the relative abundance of these four species being 135, 36, 26, and ten per acre, respectively. Of the

trees six inches and more in diameter, 81 per cent were swamp white oaks. In Table 3 this area has been combined with (3), which had the same type of growth.

(2) Two acres, about 83,600 square feet, rectangular in shape, west of (1).

All trees were cut off this area several years ago when an electrical power line was run through, and the land was covered

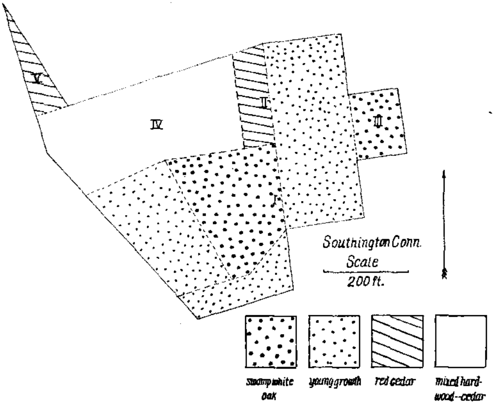

FIGURE 46. Map showing area infested by the gipsy moth in Southington, Conn., in 1929. The Roman numerals indicate the location of the sample plots. *See page 547.*

with alder, gray birch, red maple, and swamp white oak, growth four to six feet high. This area has been combined with areas (6) and (7), which were similar, in Table 3.

(3) One and four-tenths acres, about 59,600 square feet, irregularly pentagonal in shape, near the center of the infestation. Sample plot I, 248′ x 198′ (4,752 sq. ft.), taken along the eastern edge.

Swamp white oak was the predominating species at 342 trees per acre, followed by red cedar 198 per acre, American elm 135 per acre, gray birch 72 per acre, and apple 18 per acre. In the tabulation, this area has been combined with (1), to which it was similar.

(4a) Two-tenths of an acre, rectangular in shape, comprising 7,125 square feet, north of (3). Sample plot II, 45′ x 95′ (4,275 sq. ft.), taken along the east edge of the area.

This area was covered with red cedar, about 1,000 trees per acre. Underneath was a growth of alder brush up to ten feet in height.

(4b) Two and one-tenth acres, about 95,402 square feet, irregularly pentagonal in shape, on the north side of the infestation. Sample plot IV, 20′ x 337′ (6,740 sq. ft.), taken diagonally through the center.

This area was covered with a mixed growth that merges into overgrown pasture on the north and west. Red cedar was the most abundant species at 388 per acre, followed by gray birch at 245 per acre, swamp white oak 137 per acre, and a few elms and apple trees, but of the trees six inches and more in diameter, swamp white oak comprised 57 per cent and American elm 11 per cent.

(5) One-fourth acre, about 10,647 square feet, triangular in shape, on the northwest corner of the infestation. Sample plot 15′ x 126′ (1,890 sq. ft.), taken through the center.

This area was an old pasture growing up to red cedar that was present at the rate of 558 trees per acre.

(6) One and one-fourth acres, about 54,200 square feet, irregularly pentagonal in shape, on the west side of the infestation, densely covered with red cedar, red maple, and gray birch, up to ten feet in height with a very few scattered larger cedars and one or two large American elms and butternuts. In Table 3 this area has been combined with areas (2) and (7) which it resembled closely.

(7) One-half acre, about 23,681 square feet, irregularly pentagonal in shape, on the south end of the infestation.

This was also covered with red cedar, gray birch, and red maple up to ten feet in height and has been combined with the other areas of similar growth.

Beside the road bordering the west side of the infestation was a row of large shade trees, 67 in number and varying in diameter from three to 19.5 inches. Only thirteen of these trees are less than six inches in diameter and white ash and red cedar made up 50 of the total. These trees were all sprayed, but no area covered is estimated. The time taken to spray such a row is very small and would not appreciably affect the calculated spraying cost per acre.

Of the eight acres in this infested area, one and eight-tenths were covered principally with swamp white oak and two and one-tenth were covered with a mixed growth in which this species predominated among the larger trees. Three and seven-tenths acres were rather densely covered with young growth up to ten feet in

height and two-tenths of an acre were old pasture growing up to red cedar. Two-tenths of an acre were covered with a rather dense growth of red cedar. The species of trees and shrubs present and the history of the infestation both indicate that the gipsy moth will persist and be destructive for some time unless eliminated by control measures. Swamp white oak and gray birch, both favorite food plants, were abundant, and the focus of the infestation, as indicated by the location of the egg masses, was in the swamp white oak growth in the center. Red cedar and white ash are practically immune to serious attack. The insect was discovered in this area in the spring of 1924 when five egg masses were found, indicating that the infestation probably originated in 1923 or 1922. The area was sprayed in 1924 and was not scouted again until the spring of 1929, when 202 egg masses were found. Although this area may have been re-infested since 1924, the probability is that a few larvae survived the spraying of that year. If, as suggested by Fitch (1910), the annual increase of this insect in number is about six times, the number of egg masses found in 1929 would indicate that very few, possibly only one, females survived, mated, and oviposited in 1924.

2. Wethersfield, Figure 47

In the town of Wethersfield, the area infested comprised 40.7 acres of bottom land on the west bank of the Connecticut River, about one and one-half miles southeast of the center of the town. The land is level and, according to the height of the water marks on the trees, at times covered with four or five feet of water in the spring. The elevation is not great, being less than 20 feet above sea level. The ground was soft when sprayed but offered no great difficulties beyond the inconvenience of working in two or three inches of mud. The sprayer was able to get up to one corner of the infested area, and water was obtained from the river, which was about eight hundred feet from the machine. The tree growth in this area was of three types, and divisions have been made accordingly.

(1) The strip along the river bank, varying in width from about 114 feet to about 186 feet and comprising seven and eight-tenths acres, about 338,034 square feet, was covered with a dense growth of willows ten or twelve feet high, among which were a few small white maples.

(2) Back farther from the river and merging into the willow young growth was an area covered with white maples, varying in diameter from one to eight inches and growing in clumps of from five to nine trees each with a few elms and large willows and poplars in the northern part. The bases of the trees were covered with sediment to an undetermined depth, and this sediment is being added to each year when the land is flooded. The area covered

by this growth comprised 12.2 acres, about 522,266 square feet. Three sample plots were taken: II, 90′ x 405′ (36,450 sq. ft.), along the western border: III, 90′ x 228′ (20,520 sq. ft.), across the center, and VI, 90′ x 351′ (31,590 sq. ft.), near the east end. There were about 385 trees per acre in the area, the growth being more dense and of smaller trees toward the south and opening up toward the north where the trees are larger. Of the trees six inches and more in diameter, 73 per cent were white maples, 19 per cent willows, six per cent Carolina poplars, and two per cent elms. Inasmuch as almost all the willows and poplars were more than 12 inches in diameter, these trees furnished a greater proportion of the foliage to be sprayed than their relative abundance would indicate.

(3) The northern part of the infested area, 20.7 acres, about 901,114 square feet in extent, was covered with large white maples, Carolina poplars, and willows. There were about 88 trees per acre, most of them being more than 12 inches in diameter. Some of the large specimens measured about three feet in diameter and ranged in height from 100 to 135 feet. The three sample plots in this area were continuous with those in (2) and of the same width: I, 90′ x 588′ (52,920 sq. ft.); IV, 90′ x 381′ (34,290 sq. ft.); V, 90′ x 480′ (43,200 sq. ft.). The most abundant species was white maple, 65 per acre, but many of these were small. Carolina poplar, 13 per acre, was next in abundance, followed by willow, seven per acre, and elm, three per acre. Of the trees one to twelve inches in diameter, almost all were white maples, but of those twelve inches and more in diameter, 43 per cent were white maples, 36 per cent Carolina poplars, 19 per cent willows, and two per cent were elms.

In this infested area, the northern half, which was covered with large poplars, willows, and maples, provided suitable conditions for the gipsy moth to maintain itself. The southern half, except for the narrow strip of young willow growth along the river, was almost entirely white maple, and although the insect will feed on this plant, only a small percentage of the larvae develop. Moreover silt is laid down each year in this belt and would cover any egg masses placed close to the ground. The shore strip of willow brush is flooded so frequently that it probably would not constitute a dangerous area for any great length of time.

Control measures in this area have been very difficult. Spraying operations have not been successful because of the height of the trees and the uncertainty of the sudden flooding of the land. The most heavily infested trees, the poplars and willows, were so high that the tops could not be sprayed even with the pumps working at a maximum pressure. The land is so low that a very slight rise of the river floods it and renders spraying at this time impossible. In 1928, the crew had to leave in such a

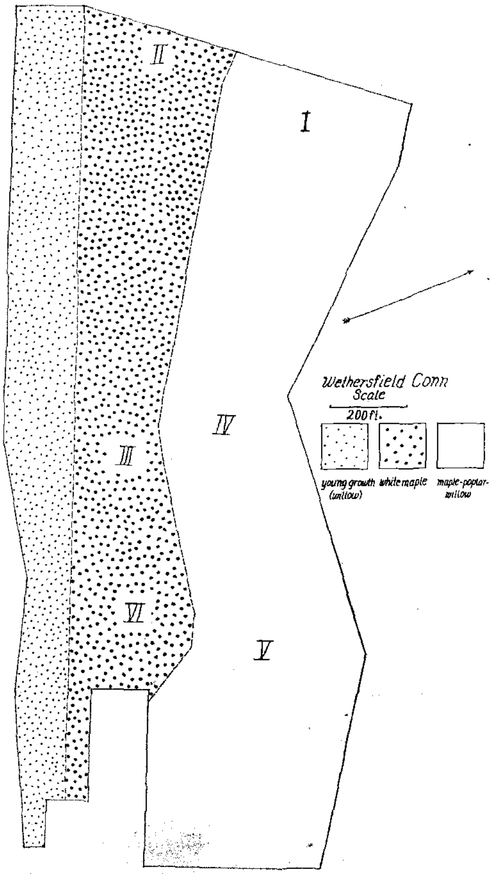

FIGURE 47. Map showing area infested by the gipsy moth in Wethersfield, Conn., in 1929. The Roman numerals indicate the location of the sample plots. See page 551.

short time that some of the hose could not be pulled out. In the fall of 1929, the number of egg masses was large in spite of the early summer spraying, and all of the ground litter, such as fallen trees and branches, was piled and burned.

The gipsy moth was first discovered here in the spring of 1928, and the trees were partly sprayed that year, work being halted because of the rise of the river, as mentioned above. Seven hundred and fifteen egg masses were found in 1928 and 791 in the spring of 1929, but thorough work was impossible in 1928 because of the spring flood. It is doubtful if the insect can ever be controlled by man in this area unless the poplars and willows are removed.

3. West Hartford, Figure 48

In the town of West Hartford, the area infested in 1929 included 22.4 acres, about 976,446 square feet, fairly evenly covered with hardwoods and hemlocks. This area is on the watershed of the Hartford Water Company reservoirs, about one-half mile east of the point where the southeast corner of Avon and the northeast corner of Farmington meet on the west boundary of West Hartford. The land is rough and slopes sharply to the east with two terraces and a deep gully. The altitude drops from 600 feet above sea level on the west to 420 feet on the east.

The tree growth was more or less typical of this part of Connecticut, and this area is the only one of the four studied which can really be considered representative of the woodland of the region. There were no open areas of old fields or pastures, and many of the common hardwood species found in this part of the state were present in more or less abundance. The eastern half of the infested area contained principally hemlock and chestnut oak to the south and chestnut oak and sugar maple to the north. The western half contained principally chestnut oak, sugar maple, white ash, red oak, hemlock and linden. Hemlock was concentrated in the center of the area and diminished in all directions. Sugar maple was rare in the center of the area and chestnut oak was rare in the northwest part. In the western and northern part of the area there was much sugar maple reproduction, and small dogwoods (Cornus), American hornbeams (Carpinus), and hop hornbeams (Ostrya), were more or less abundant. Hickory was fairly well scattered throughout and was the fourth most abundant tree. The three common species of hickory (shagbark, pignut, and mockernut) are here grouped together.

The seven sample plots taken in this area are indicated on the map and were of the following extent: I, 90′ x 129′ (11,610 sq. ft.); II, 90′ x 174′ (15,660 sq. ft.); III, IV, V, VI, and VII each 90′ x 150′ (13,500 sq. ft.). The average number of trees per acre was 392, varying from 283 in the northeast and 320 in the

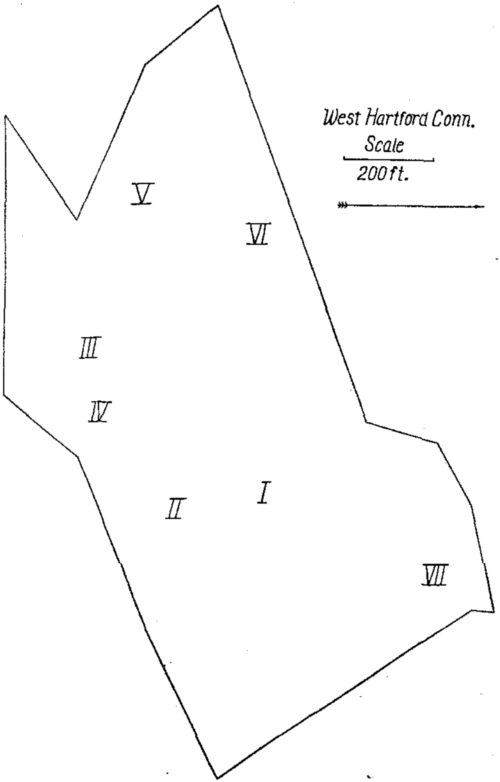

FIGURE 48. Map showing area infested by the gipsy moth in West Hartford, Conn., in 1929. The Roman numerals indicate the location of the sample plots. See page 553.

southwest to 558 in the center. Of the species present, hemlock was the most abundant, representing 24 per cent of the total number, followed by sugar maple 17 per cent, chestnut oak 15 per cent, hickory 11 per cent, white ash seven per cent, red oak five per cent, and linden five per cent. Other species were less abundant. Of the trees six inches or more in diameter, chestnut oak made up 28 per cent, hemlock 20 per cent, hickory 14 per cent, red oak ten per cent, sugar maple ten, white ash, eight, white oak, four, linden, five, and American elm, one. There was an average of 168 trees per acre of this size.

No difficulty was experienced in spraying the trees, and even though one of the men inadvertently stepped on a copperhead, the morale of the crew was excellent. The sprayer was stationed beside a brook about 400 feet away, which furnished water. A good hard road runs almost to the east border of the area.

On the basis of food plants present, this area was certainly favorable to the gipsy moth. The oaks and linden are favorite food plants, and hemlock is favored by the later larval instars. Larvae also feed to some extent on hickory and sugar maple, although if these latter species are not mixed with others more favored, they would not suffer any serious injury. White ash foliage is not eaten by the larvae.

The insect was first discovered in the spring of 1929 when 486 egg masses were found. In the winter of 1929-1930, 205 new egg masses were found. Inasmuch as the removal of the favorite food plants would mean the cutting of about 48 per cent of the best trees, such a procedure cannot be advocated. This site is a watershed for a public water supply, and expensive control measures are therefore justifiable. There is a large area of similar woodland around the infestation, which may make eradication difficult.

4. Avon, Figure 49

The area infested in Avon comprised 23.9 acres of old pasture on the western side of a ridge about one and one-half miles north of the Avon-Farmington line and about one-half mile west of the Avon-West Hartford line. The land slopes to the west, dropping from an altitude of 500 feet above sea level to 400 feet in a distance of one-fourth of one mile. Bordering the eastern edge of the infestation is a bluff about 150 feet high. To the west was overgrown pasture, but on the north, east, and south there was a growth of young hardwoods.

Seven sample plots were taken, one (II) in the brush area on the western side, 90′ x 150′, 13,500 square feet; one in each of the hardwood areas on the northeast side (III and V), 90′ x 150′; one (VIII) in the hardwood area near the western border, 75′ x 150′, 11,500 square feet; three (I, VI, and IX) in the

remainder of the area, all of which was uniformly covered with red cedar, each 90′ x 150′.

Most of the infested area, about 19.2 acres, was grassland on which was a growth of small red cedars 10 to 20 feet high, about

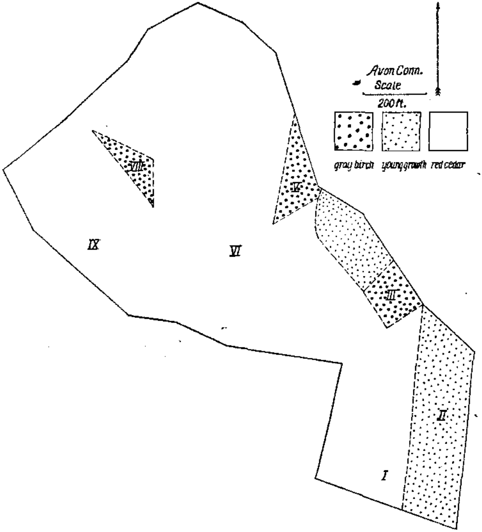

FIGURE 49. Map showing area infested by the gipsy moth in Avon, Conn., in 1929. The Roman numerals indicate the location of the sample plots. See page 555.

348 trees per acre, with a few hardwoods of small size. Along the eastern side were about 2.7 acres of young growth pasture reverting to hardwood growth, with about six large red and white oaks and sugar maples 30 to 35 inches in diameter. On the northeast side was an area of about eight-tenths of an acre of similar character. There were three small areas of young hardwoods, two on the northeast side of about five-tenths and four-tenths of an acre respectively, and one near the center of the western side of three-tenths of an acre. On the hardwood areas, which had

similar types of growth, gray birch was the predominating species, averaging about 405 trees per acre, intermixed with which were red cedars at about 66 trees per acre, hop hornbeam at about 51 per acre, black birch at about 26 per acre, American elm at about 14 per acre, and sugar maple at about 11 per acre. There were also a few red oaks, staghorn sumacs, pitch pines, white pines, hickories, red maples, tupelos, and white ashes present and an undergrowth of witch hazel. This last species was quite abundant, averaging about 139 per acre. The growth in the hardwood areas was small, only four per cent of the total number of trees, including witch hazel, which is really a shrub, being more than six inches in diameter, and only one-third of one per cent of the total number being greater than nine inches in diameter. According to the location of the egg masses, the infestation centered in the hardwood area near the western border.

The spraying of the infested area was somewhat delayed because water had to be hauled from a brook about one-half mile away. The ground was wet, due to seepage, but this did not hamper the crew either in laying the hose or in spraying the trees. The open nature of the cedar growth and the small size of the trees permitted fairly rapid work while the pump was running.

The establishment of a permanent gipsy moth infestation in this area would have to occur in the small areas of hardwoods where favorable food plants are found. The only favored food plants of all larval instars were gray birch and witch hazel, which were moderately abundant and made up much of the stand in these small areas. The red cedars, which constituted most of the growth over the entire area, are fed upon very slightly, and the probability of an infestation being established in a cedar growth is extremely remote. However, the proximity of hardwood growth, much of it favorable to the development of the insect, in the region around the infestation, and the exposure of the infested area to winds renders great the danger of spread.

The gipsy moth was first discovered here in the winter of 1928-1929 when 328 egg masses were found. In the winter of 1929-1930 seven egg masses were found, of which only three were new, that is, contained eggs laid in 1929.

The cost of spraying all four areas, the materials used, and the time necessary are summarized in Tables 1 and 2. For the Avon infestation, gasoline and oil have been computed on the same basis as for the others, even though the water was hauled. The difference between the amount used in this case and that which would have been used had water been pumped is negligible. The cost per acre varies from $11.15 in the Southington area to $21.31 in the West Hartford area. This cost is dependent on the amount of materials and time used and on the depreciation of the equipment and does not indicate the efficiency of the operation. Depre-

ciation of equipment accounts for about 50 per cent of the total cost per acre. This is due to the relatively small part of the year during which the equipment can be used.

The efficiency of the spraying operation, which in this case cannot be measured by the reduction in the number of egg masses found from year to year because the control is partly effected by treating the eggs with creosote, is indicated by the lead arsenate-time ratio in Table 2. The factors causing the variation in cost per acre are brought out in considering this ratio. The amount of foliage covered by the spray should be indicated by the amount of lead arsenate used. This represents work done. If this figure is divided by the time taken to spray the area, the result should give an index of the work accomplished per unit of time, and the higher the figure is, the more is the work accomplished, that is, the greater is the efficiency. This figure represents the facility with which work was done and has no bearing on the skill of the crew.

It is readily seen that although the cost per acre in the Wethersfield area was slightly greater than in the Southington area, nevertheless, the former area was more efficiently and hence more economically sprayed. It is also evident that although the Avon area cost less per acre than the West Hartford area, the Avon area was much less efficiently, and hence less economically, sprayed, and was, in fact, the most expensive of the four. When time alone is considered, the Wethersfield area cost least, and when foliage to be covered, as indicated by the lead arsenate used, is considered, the Southington and Avon areas are both below the Wethersfield area. The West Hartford area, which is the only one of the four covered by a woodland growth "typical" of the region, took the most time and the most lead arsenate per acre, yet the efficiency of the operation was neither the highest nor lowest, being below the Wethersfield area and above the other two.

The reason for the variation in cost per acre and efficiency of operation is due, as has been suggested previously, to the type of tree growth and the character of the site. In view of the fact that the depreciation cost depends on the time taken to spray the area, the facility with which spraying is accomplished affects this cost. At Wethersfield, the terrain was flat and the trees were easily sprayed. The ground was clear, the equipment easily handled, and the sprayer stationed beside the infestation. At West Hartford, the terrain was rough and hilly; there was much small growth under the trees, and the trees were more numerous. It is true that up to a certain extent the increase in trees per acre enables a larger amount of foliage to be sprayed per hour, but after a certain density has been attained, it is also probably true that this gain is more than offset by the difficulty in manipulating the hose line.

TABLE 1. COST OF SPRAYING WOODLAND

Infestation	Acres	Lead arsenate	Fish oil	Gallons spray	Gasoline[1]	Lubricating oil[5]	Feet hose	Time	Depreciation of equipment	Cost (including labor)
Southington	8.0	120 lbs.	none	2,400	12 gals.	1.3 qts.	2,000	4 hrs.	$ 44.12	$ 89.18
Wethersfield	40.7	950	7 qts.	15,200[2]	54.5	5.6	3,400	18.10	200.38	456.65
West Hartford	22.4	775	62	12,400[3]	61.5	6.0	2,800	20.30	226.12	477.39
Avon	23.9	450	none	7,200[4]	55.5	5.7	3,500	18.30	204.06	399.06

[1] Based on three gallons per hour for pumper and sprayer combined.
[2] 38 tanks.
[3] 31 tanks.
[4] Based on 450 pounds lead arsenate at one pound per 16 gallons of water.
[5] Based on 2.5 quarts per day for sprayer and pumper.

TABLE 2. COST OF SPRAYING WOODLAND

Infestation	Time per acre	Labor cost per acre	Lead arsenate per acre	Lead arsenate cost per acre	Per cent cost labor	Per cent cost lead arsenate	Lead arsenate—time ratio	Depreciation per acre	Per cent cost depreciation	Total cost per acre
Southington	30 min.	$3.45	15 lbs.	$1.91	31	17	.50	$ 5.52	50	$11.15
Wethersfield	27	3.00	23.3	2.90	27	26	.86	4.78	43	11.22
West Hartford	55	6.31	34.6	4.41	30	21	.63	10.12	47	21.31
Avon	46	5.33	18.8	2.40	31	14	.41	8.46	51	16.70

TABLE 3.

Infested area	Type	DBH	Trees per acre: Alder	Apple	Beech	Birch, gray	Linden	Oak, black	Oak, chestnut	Oak, red	Oak, swamp white	Oak, white
Southington 8 acres	(1)+(3) 1.8 acres	1–5.5″	..	14	..	51	..	..	..	..	73	..
		6–11.5	..	..	..	7	..	..	..	..	200	..
		12–17.5	..	..	..	..	..	..	..	..	23	..
		Total	..	14	..	58	..	..	..	..	296	..
	(4b) 2.1 acres	1–5.5″	..	39	..	192	..	..	..	..	28	..
		6–11.5	..	..	..	53	..	7	..	..	74	..
		12–17.5	..	..	..	..	..	..	..	..	35	..
		Total	..	39	..	245	..	7	..	..	137	..
	(4a) 0.2 acres	1–6″	..	..	..	..	..	..	..	..	..	..
	(5) 0.2 acres	1–4″	..	..	..	..	..	..	..	..	..	..
	(2)+(6)+(7) 3.7 acres	Young growth	..	..	..	..	..	..	..	..	..	..
	Roadside trees	1–5.5″	..	..	..	..	..	..	..	..	2	..
		6–11.5	..	..	..	..	..	2	..	..	1	..
		12–17.5	..	..	1	..	..	2	..	..	..	..
		18–23.5	..	..	..	..	..	..	..	..	..	..
		Total	..	..	1	..	..	4	..	..	3	..
Wethersfield 40.7 acres	(1) 7.8 acres	Young growth	..	..	..	..	..	..	..	..	..	..
	(2) 12.2 acres	1–5.5″	..	..	..	..	..	..	..	..	..	..
		6–11.5	..	..	..	..	..	..	..	..	..	..
		12–17.5	..	..	..	..	..	..	..	..	..	..
		18–23.5	..	..	..	..	..	..	..	..	..	..
		24–29.5	..	..	..	..	..	..	..	..	..	..
		30–35.5	..	..	..	..	..	..	..	..	..	..
		Total	..	..	..	..	..	..	..	..	..	..
	(3) 20.7 acres	1–5.5″	..	..	..	..	..	..	..	..	..	..
		6–11.5	..	..	..	..	..	..	..	..	..	..
		12–17.5	..	..	..	..	..	..	..	..	..	..
		18–23.5	..	..	..	..	..	..	..	..	..	..
		24–29.5	..	..	..	..	..	..	..	..	..	..
		36–41.5	..	..	..	..	..	..	..	..	..	..
		Total	..	..	..	..	..	..	..	..	..	..
West Hartford 22.4 acres		1–5.5″	..	..	..	..	9	..	10	4	..	3
		6–11.5	..	..	1	..	8	..	40	11	..	6
		12–17.5	..	..	..	..	1	..	7	5	..	1
		Total	..	..	1	..	18	..	57	20	..	10
Avon 23.9 acres	(1) 1.2 acres	1–5.5	..	..	..	399	..	..	..	1	..	..
		6–11.5	..	..	..	6	..	..	..	..	..	..
		30–35.5	..	..	..	..	..	..	..	..	..	..
		Total	..	..	..	405	..	..	..	1	..	..
	(2) 19.2 acres	1–5.5″	2	..	..	15	..	..	..	..	..	..
		12–17.5	..	..	..	..	..	..	..	..	..	..
		30–35.5	..	..	..	..	..	..	..	2	..	2
		Total	2	..	..	15	..	..	..	2	..	2
	(3) 3.5 acres	Young growth	..	..	..	..	..	..	..	..	..	..

TREE GROWTH

Trees per acre																				
Poplar, Carolina	Sumac, staghorn	Willow	Witch-hazel	Hemlock	Pine, pitch	Pine, white	Birch, black	Cherry, black	Elm, American	Hickory	Hornbeam, American	Hornbeam, hop	Maple, red	Maple, sugar	Maple, white	Ash, white	Butternut	Cedar, red	Dogwood	Total
..	..	..	..	..	..	..	..	7	59	..	7	..	..	..	..	..	..	160	..	..
..	..	..	..	..	..	..	..	..	54	..	..	..	1	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	7	..	..	..	..
..	..	..	..	..	..	..	..	7	113	..	7	..	1	..	..	7	..	160	..	663
..	..	..	..	..	..	..	..	..	21	..	..	..	..	..	..	..	..	381	..	..
..	..	..	..	..	..	..	..	..	21	..	..	..	..	..	..	..	..	7	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	42	..	..	..	..	..	..	..	..	388	..	858
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1,000	..	1,000
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	558	..	558
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	1	1	1	..	..	..	..	..	3	..	5	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	15	..	13	..	..
..	..	..	..	..	..	..	..	1	..	..	..	..	4	..	..	6	..	7	..	..
..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	1	..	..	..	..
..	..	..	..	..	..	..	..	2	2	1	..	..	4	..	..	25	..	25	..	67
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	5	..	..	..	..	..	..	13	..	..	..	..	..	259	..	..	..	..	..
..	..	9	..	..	..	..	..	..	2	..	..	..	..	..	77	..	..	..	..	..
2	..	9	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..
1	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
2	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
6	..	26	..	..	..	..	..	..	15	..	..	..	..	..	338	..	..	..	..	385
..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	33	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	17	..	..	..	..	..
3	..	3	..	..	..	..	..	..	..	..	..	..	..	..	10	..	..	..	..	..
6	..	2	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..
3	..	2	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
13	..	7	..	..	..	..	..	..	3	..	..	..	..	..	65	..	..	..	..	88
..	..	..	..	64	..	..	3	..	5	19	10	15	3	50	..	16	..	..	13	..
..	..	..	..	25	..	1	..	..	1	23	..	..	..	15	..	12	1	..	..	..
..	..	..	..	8	..	..	..	..	..	..	..	..	..	1	..	1	..	..	..	..
..	..	..	..	97	..	1	3	..	6	42	10	15	3	66	..	29	1	..	13	392
..	..	..	139	..	3	1	16	..	11	4	..	50	3	7	..	3	..	63	..	..
..	1	..	..	..	2	..	10	..	3	1	..	1	..	2	..	..	..	3	..	..
..	..	..	..	..	..	..	..	..	..	1	..	..	..	1	..	..	..	..	..	..
..	1	..	139	..	5	1	26	..	14	6	..	51	3	11	..	3	..	66	..	732
..	..	..	1	2	..	..	1	..	2	..	..	..	..	1	..	..	1	348	2	..
..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	1	2	..	..	2	..	2	..	..	..	..	1	..	..	1	348	2	380
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Southington was the smallest area and the amount of time consumed in laying and taking up the hose was probably relatively greater than in the other areas. There was considerable undergrowth and the condition of the ground was far less suitable for working than in Wethersfield. This was the first area sprayed by the crew in 1929, and there may have been some delay due to inexperience with the equipment. The small amount of lead arsenate used per acre was due to the large areas of brush. At Avon, conditions were far from favorable for good work. Water had to be hauled about half a mile. The trees were small and scattered, and the hillside was irregular and rough. Although the amount of lead arsenate per acre was only slightly more than at Southington, the time per acre was half again as much. Furthermore, the sprayer was farther from the infestation than in the other areas, necessitating relatively and actually more hose laying. The conditions at Avon were such that efficient work was impossible.

As has been mentioned before, the area at West Hartford is more nearly typical of woodland conditions in this part of Connecticut than are the other areas. The cost, $21.31 per acre, is probably a good basis for estimating the cost of woodland spraying in this state. Yet conditions under which gipsy moth spraying must be carried on vary, and these conditions cause immense differences in cost. Worthley (1917) has estimated the cost as being about $5.50 per acre, about 600 gallons of spray per acre being necessary. On this basis, the lead arsenate cost, at his figure of five cents a pound for *paste,* would be $3.75 per acre and labor and other costs $1.75. At West Hartford, it cost $4.41 per acre for lead arsenate, at 12.75 cents a pound for *powder,* and 554 gallons of spray per acre were necessary. The labor cost was $6.31 per acre. Other costs were $10.72 per acre. It can be readily seen that the main difference in cost is due to the labor and depreciation charges. The West Hartford area of 22.4 acres took 20.5 hours, or about nine acres per eight hours of actual spraying. Worthley estimated 12 to 15 acres a day as an average for one crew, but does not state just what characterizes an "average acre" nor the number of men per crew and the number of spraying hours in a day. The crew for the West Hartford area is given on page 546. We have attempted to describe the areas here concerned, so that not only can an idea of the cost be ascertained, but also so that some conception of the conditions that affect the cost can be realized.

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THE SPREAD AND CONTROL OF THE EUROPEAN CORN BORER IN CONNECTICUT

W. E. Britton and M. P. Zappe

There was a marked westward spread of the European corn borer in Connecticut in 1928, 34 new towns being found infested. All except Suffield were connected with the large infestation of

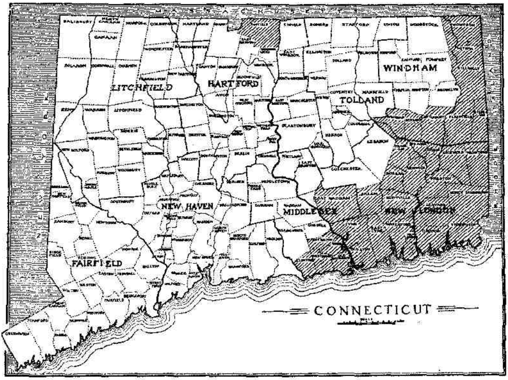

FIGURE 50. Map of Connecticut showing areas now under State and Federal quarantine on account of the European corn borer.

the double-brooded corn borer, which extends throughout Rhode Island, eastern Massachusetts, southern New Hampshire and southeastern Maine. The town of Suffield was found infested with the one-generation or single-brooded area that reaches into western Massachusetts from New York. These areas are shown in Figure 50.

After due notice and a public hearing at the Station on February 25, 1929, a quarantine order was issued in accord with Federal

Quarantine No. 43, sixth revision, effective March 1, 1929. The state quarantine became effective March 15, 1929. It is as follows:

STATE OF CONNECTICUT

AGRICULTURAL EXPERIMENT STATION

NEW HAVEN, CONN.

Quarantine Order No. 21

CONCERNING THE EUROPEAN CORN BORER

The fact has been determined that the European corn borer, *Pyrausta nubilalis* Hubn., has spread to such an extent as to make it necessary to extend the area restricted by State Quarantine Order No. 13, effective June 1, 1927, and likewise to bring it into conformity with Federal Quarantine No. 43, sixth revision, effective March 1, 1929.

Now, therefore, I, Director of the Connecticut Agricultural Experiment Station, do hereby proclaim the following towns (including those affected by Quarantine Order No. 13) to be under quarantine and subject to the restrictions and regulations made a part of Federal Quarantine No. 43, as revised, and effective March 1, 1929:

Regulated Areas

Two-Generation area: Clinton, East Haddam, Essex, Old Saybrook, Saybrook, and Westbrook in Middlesex County; Bozrah, East Lyme, Franklin, Griswold, Groton, Ledyard, Lisbon, Lyme, Montville, New London, North Stonington, Norwich, Old Lyme, Preston, Salem, Sprague, Stonington, Voluntown and Waterford in New London County; Canterbury, Killingly, Plainfield, Putnam, Scotland, Sterling, Thompson and Windham, in Windham County.

One-Generation area: Suffield, in Hartford County.

Movement of Restricted Plants

Until further notice, unless accompanied by a certificate or permit issued by an authorized inspector of the State or Federal Plant Quarantine and Control Administration, the following plants and plant materials cannot be allowed movement from the restricted areas to points outside, or from the two-generation area into the one-generation area or from the one-generation area into the two-generation area: Corn, broom corn, sorghum and sudan grass including all parts of leaves and stalks throughout the year; from the two-generation area all cut flowers and entire plants of chrysanthemum, aster, cosmos, zinnia, hollyhock, gladiolus and dahlia (except gladiolus and dahlia bulbs without stems) and for the period between June 1 and December 31, all celery, green beans in the pod, beets with tops, rhubarb, oat and rye straw as such or when used as packing.

No restrictions are placed on the movement of shelled corn in packages weighing two pounds or less; larger quantities must be certified.

This order shall take effect March 15, 1929.

W. L. SLATE,
Director, Connecticut Agricultural Experiment Station

Approved:
JOHN H. TRUMBULL, *Governor.*

This quarantine order, together with brief information about the corn borer, was published as Bulletin of Immediate Information 63, in an edition of 11,000 copies and was distributed widely

in the infested territory. The accompanying map shows the area quarantined in Order No. 21, and was printed in Bulletin of Immediate Information 63; this publication also contained information and recommendations regarding clean-up and control, as follows:

Methods of Clean-up and Control

For the past five years, the stalks, stubble and weeds have been burned in and around each separate infestation in Connecticut at the expense of the State and Federal governments, and in many cases no borers were found the next season. With the large number of towns infested, appropriations are inadequate to continue this system, and the grower must control the pest in his cultural operations. As the borers pass the winter in corn stalks, stubble and weeds, the following methods of handling the infested crop will greatly reduce the injury next season:

1. Corn stalks should be cut just as early as possible after maturity and put in the silo or fed out to cattle. When fed out, uneaten portions of stalks should be destroyed. If allowed to stand, such stalks furnish a favorable shelter for borers.
2. If cut close to the surface of the ground, very few borers will be contained in the stubble. If cut 6-12 inches high, the stubble may furnish enough borers to ruin the crop the following year, and such stubble should be plowed under cleanly, or pulled and burned.
3. Corn stalks which are not cut and used for silage or fodder should be burned in the field or cleanly plowed under. The larger weeds in the field and around their margins should also be burned.
4. By clean plowing in the fall, a large percentage of the second-brood borers are killed during the winter. Fall plowing is somewhat less effective against the single-brooded borers, but against both one-generation and two-generation borers, early spring plowing, during April, is beneficial, especially if all debris is covered deeply. There are now plows and attachments devised to facilitate the clean plowing under of standing corn stalks, and your county agent can advise you regarding them.
5. Small patches of sweet corn in back yard gardens can perhaps be pulled and burned to best advantage. If not cleaned up, such places will produce enough borers to infest the entire countryside.

Publicity

In scouting in 1928, the Federal scouts in each town worked until an infestation of the European corn borer was found and confirmed by a laboratory identification, then they moved to the next town. Consequently, it was unknown what proportion of the infestations were discovered in any given infested town. If no borers were found, the scouts examined every corn patch in the entire town. But as so many towns were found infested and not completely scouted, it was impossible for the state forces to conduct any clean-up or other control operations such as has been the practice for several years, other than distributing information and other publicity among the corn growers. It was deemed best to do everything possible under the existing conditions to prevent the spread and increase of this destructive insect. Consequently, a publicity campaign was decided upon to warn

the growers in the infested towns that the pest was present in their midst and to urge them to carry out the recommended measures of control.

In the town of Suffield and likewise in the towns on the western margin of the infested area, all of the rural districts were visited by Mr. Zappe and two Federal men during April. These men stopped at farms where they saw corn stalks and stubble still in the fields, and personally requested the owners or managers to dispose of this material as soon as possible. A copy of the quarantine and clean-up regulations was given them for reference. Where no corn was found, a copy was left at the house or in the mail box. In the infested towns east of the margin of the quarantined area, by permission of the Postoffice Department the rural mail carriers greatly assisted us by leaving a copy in each mail box along their routes. In all infested towns, the school teachers were requested to inform the children about this pest and ask their parents to dispose of all material that might contain larvae of the European corn borer. This seemed a satisfactory means of publicity as the children could easily explain to their parents the necessity for cleaning up. It was very difficult in some cases for our men to explain the matter to persons not familiar with the English language. All newspapers in the infested area assisted us by calling attention in their pages to the necessity for prompt measures of control.

This work required about 16 days each for three men, or 48 man days.

The Federal authorities had immediate charge of enforcing the quarantine regulations, and maintained a road patrol at 12 different stations on the main thoroughfares leading out of the quarantined area. At these stations considerable infested material was intercepted, containing altogether some 1,581 borers. More than half of these borers were intercepted on the Boston-New York Post Road at Station No. 12 on the Clinton-Madison town line. Illustrations of corn borer injury, plowing demonstrations and road patrol work are shown on Plates XIII, XIV, and XV.

Legislation Providing Compulsory Control

Owing to the recent rapid spread of the corn borer in Connecticut, it was foreseen that the cost of clean-up in such a large territory would be too great to be defrayed by public funds. Consequently it will be necessary for each grower to dispose of his own corn stalks and stubble. A certain proportion of growers will do this voluntarily for their own benefit; but others will not do so except under pressure. In order to make it possible to clean up all fields, the General Assembly of 1929 enacted the following law:

PUBLIC ACTS OF 1929

CHAPTER 171

AN ACT CONCERNING THE CONTROL OF THE EUROPEAN CORN BORER

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. The director of the Connecticut Agricultural Experiment Station shall issue and publish orders, rules and regulations which shall be effective in any town or portion thereof which shall have been quarantined on account of the European corn borer as provided by chapter 31 of the public acts of 1927, which orders, rules and regulations may require that each owner, tenant or manager of land on which corn of any kind has been grown shall, not later than December first of the year of its growth, plow or cause to be plowed the field in which it was grown, so as to bury the stubble to a depth of at least six inches, or pull up and destroy such stubble or cause it to be pulled up and destroyed by burning, and each person having in his possession corn stalks shall, not later than April tenth of the year following that of their growth, completely dispose of such corn stalks by using them as fodder or by burning them, and shall destroy, or cause to be destroyed, on or before April tenth of each year, all weeds in such areas as may be designated by the director of the Connecticut Agricultural Experiment Station.

SEC. 2. Any person who shall violate any provision of this act or any order, rule or regulation issued by authority of any such provision shall be fined not more than one hundred dollars.

Approved June 3, 1929.

Difference Between the European Corn Borer and Other Burrowing Larvae Found in Corn

Each year many specimens are received from growers who find a "worm" feeding upon corn or tunneling in the stalk, and suspect it to be the European corn borer. Usually it proves to be either the stalk borer or the corn ear worm. In order that growers and others may learn to distinguish between these three insects, the brief descriptions and illustrations given below were prepared in the summer and sent to all County Farm Bureau Agents and all newspapers in the state. Many prints of the illustrations were sent in letters to correspondents. Both illustrations and descriptions were also published in *The Rural New-Yorker,* issue of October 5, 1929. Apparently most of the newspapers did not print the illustrations but many printed the descriptions.

The accompanying illustration, Figure 51, shows the European corn borer and two other common insects that are often confused with it in the public mind—all twice natural size, but showing comparative sizes and difference in markings.

The corn ear worm, *Heliothis obsoleta* Fabr., is a native American insect, very common in the southern and western states, where it is called the "cotton boll worm" and the "tomato boll worm" and where it has several generations each season. It is nearly two inches long and is distinctly striped lengthwise but varies in color

from light green to dark brown or purple. It feeds upon the silk and kernels at the tip of the ear, but sometimes works downward to the base of the ear. It is not a real borer and does not tunnel in the stalks. It is brought into Connecticut each season on early sweet corn from the south, and flights of the moths occur in September in some years. All attempts to bring it through the winter at outside temperatures in Connecticut have failed.

The stalk borer, *Papaipema nitela* Guen., is also an American species. The full-grown larva is about one and one-half inches long and distinctly striped lengthwise, one of the stripes extending forward upon the side of the head. There is also a dark girdle around the front half of the body. This borer attacks a stalk here and there and usually tunnels up or down, in the stalk,

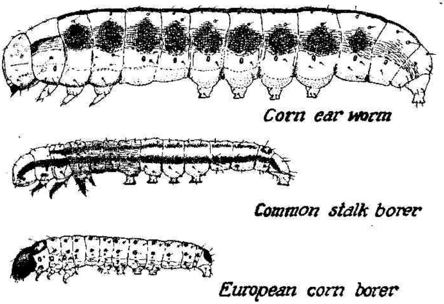

FIGURE 51. Appearance and proportionate sizes of three burrowing larvae found in corn.

but is not limited to corn and may be found in potato, tomato, dahlia, hollyhock, aster, lily, zinnia or any herbaceous stalk, even in weeds.

The European corn borer, *Pyrausta nubilalis* Hubn., has a larva an inch or less in length, white, gray, or pink in color marked with small black dots, but it is not distinctly striped. It burrows crosswise and lengthwise in the stalks, leaf-veins, and ears, including the cob, and when abundant will soon ruin the field. Though primarily a pest of corn, when the infestation becomes severe, the borers enter the stalks of celery, rhubarb, beet, bean, gladiolus, dahlia, aster, zinnia, chrysanthemum, and some of the larger grasses and weeds. This is the insect against which the quarantine was established and is now being enforced in the eastern part of Connecticut by Federal and state forces in coöperation.

TESTS OF VARIOUS APPLE SPRAYS

M. P. Zappe

Some of the fruit growers of Connecticut have been trying in many ways to eliminate the so-called spray injury, which most men believe is due to the use of lime-sulfur in combination with other spray materials. No doubt they are right; this injury to the foliage and indirectly to the fruit has become worse during the later years. Possibly high spraying pressures have contributed their share toward making this injury serious.

Other factors also have an influence on the russetting of fruit. One of these is weather conditions. Some of the fruit from the check plots that had no spray of any kind showed some russetting, though not so much as the same variety in a sprayed plot.

Various chemicals have been recommended from time to time to eliminate or to lessen the russetting and the spray injury. Iron sulfate has been used successfully for this purpose in Michigan.

We tried it last summer at the Experiment Station orchard at Mount Carmel, which contains 96 trees planted in 1911. This orchard was divided into five plots and the following spray combinations were used:

1. Iron sulfate plot:

Liquid lime-sulfur	3 gallons
Iron sulfate	1½ pounds
Black Leaf 40	1 pint
Arsenate of lead	3 pounds
Water	100 gallons

2. Liquid lime-sulfur plot same formula as the iron sulfate, except that the iron sulfate was omitted.

3. Dry lime-sulfur same as liquid lime-sulfur plot, except that six pounds of dry lime-sulfur was substituted for the liquid lime-sulfur.

4. The fourth plot was a combination plot upon which no lime-sulfur of any kind was used. This plot received the following treatment. For the pre-pink and pink sprays:

Scalecide	1 gallon
Sulfocide	½ gallon
Water	100 gallons

The calyx and later sprays were made up as follows:

Sulfocide	⅛ gallon
Kayso	2 pounds
Arsenate of lead	2 pounds
Water	100 gallons

All plots were given the same number of treatments, beginning with the pre-pink spray, this being followed by the pink, calyx,

7-day, two weeks, and the last spray on July 9. The varieties of apples used in the final check-up of results were Baldwin, Greening, McIntosh, and Roxbury Russet.

Appearance of Foliage During Summer

The leaves showed little injury in the early part of the spraying season. On June 10, the orchard was examined for spray injury. At this time a small amount of injury could be seen on all of the plots, most of it being on the liquid lime-sulfur plots. This examination was made before the last application of spray. Later in the season, the orchard was again examined very carefully. At this time, all plots were somewhat injured. The injury was divided into four classes: very light, light, medium, and heavy.

Iron sulfate plots—Most of the injury was considered moderate, 54%, and light, 33%.

Liquid lime-sulfur plot—Most of the injury was moderate, 50% with eight per cent in the heavy injury class.

Dry lime-sulfur plot—Most of the injury was classed as very light, 54%, to light, 33%.

Sulfocide-scalecide plot—Largest amount of injury was considered light, 50%; in the moderate injury class there was 33% and 16% of the injury was considered heavy.

Results at Harvest Time

All the fruit at time of picking was scored for insect injuries, fungous diseases, and for russetting, however slight. All fruits classed as good were entirely free from any injury except limb bruises or other mechanical injuries. The following table shows the result of the scoring of the fruit expressed in percentages:

	Iron sulfate	Liquid lime-sulfur	Dry lime-sulfur	Sulfocide scalecide	Check
Russet					
Good	75.0	73.0	66.8	48.0	8.6
Cod. moth	3.3	2.6	3.6	10.0	21.1
Curculio	13.0	19.2	24.1	37.9	74.3
Scab	.3	.1	.7	3.1	13.9
Russet	1.4	1.1	1.3	.0	.66
Other	7.6	4.4	3.9	3.8	7.0
Aphis	.0	.4	.5	.7	4.6
Baldwin					
Good	12.1	21.2	22.4	38.8	8.7
Cod. moth	6.9	3.4	2.1	1.4	34.5
Curculio	47.0	47.1	34.5	44.0	81.1
Scab	.2	.1	.2	.3	1.4
Russet	61.9	43.6	50.3	20.8	12.6
Other	4.7	2.3	2.3	2.4	5.4
Aphis	.4	.8	2.0	1.5	.7

	Iron sulfate	Liquid lime-sulfur	Dry lime-sulfur	Sulfocide scalecide	Check
Greening					
Good	37.9	59.0	60.3	68.8	11.7
Cod. moth	4.7	5.4	3.8	2.8	30.0
Curculio	44.9	22.8	31.9	23.4	79.6
Scab	1.0	.3	.7	1.1	3.7
Russet	13.0	10.3	2.1	.8	.4
Other	5.0	3.9	3.5	3.5	5.8
Aphis	.9	.2	.3	1.1	1.1
McIntosh					
Good	47.0	41.9	50.8	45.7	.16
Cod. moth	1.87	3.4	1.3	.8	8.4
Curculio	40.9	44.9	40.5	39.8	69.4
Scab	6.45	8.37	6.55	11.7	97.7
Russet	2.2	2.4	1.7	2.6	.0
Other	4.2	3.1	2.1	4.4	3.7
Aphis	.03	.02	.0	.0	.0

Summary

From a study of these figures, it would seem that the iron sulfate treatment showed no great advantage over either of the other lime-sulfur plots. The dry lime-sulfur and the liquid lime-sulfur were about equal in efficiency, but the fruit from the dry lime-sulfur plot had a better finish. The sulfocide-scalecide treatment was very good, showing a higher percentage of good fruit in three of the four varieties used in the tests. Basing the conclusions on one year's work in Connecticut, the iron sulfate has no advantage over any of the standard sprays, but needs further investigation. We hope to be able to make some further tests of sprays on apples with some modification of the spray formulas next year and to try out other promising spray combinations.

A STUDY OF VARIOUS OILS AND EMULSIONS FOR KILLING THE EGGS OF THE EUROPEAN RED MITE

Philip Garman

Extensive use of oils to control the European red mite (*Paratetranychus pilosus* C. & F.) has brought onto the Connecticut market a number of sprays that vary in composition so much that it has seemed advisable to study in detail the properties of different lubricating oils in order to lay down general principles governing their effectiveness for red mite control.

Several years ago about 20 oils were secured from different sources and submitted to the Department of Chemistry of this

Station for analysis. Mr. H. J. Fisher's report is found in part in Table 4. The oils after analysis were emulsified uniformly and sprayed systematically on marked areas containing red mite eggs, from which the dead and hatched eggs were carefully removed. Even with this procedure considerable variation occurred, so that it has been felt that some other means must be employed if direct comparison of the oils themselves is to have significance. A series of oils were therefore selected, dissolved in gasoline and sprayed upon the eggs. Four per cent oil in gasoline proved too strong, so the percentage was reduced to one per cent. The results showed some striking differences in oils of the same viscosity, which on investigation appeared to be the result of certain properties not listed in the table.

Owing to the small size of the experiment, it was repeated the following year and greater care was used in selection of eggs, spraying and handling, the eggs being subsequently hung in the open. Confirmation of the earlier experiment was not obtained, the two different oils of similar viscosity showing the same mortality within one or two per cent. It thus seems to be established that the main factor affecting kill of red mite eggs in pure oils of the types studied, lies in viscosity and not so much in properties such as sulfonation, cold test or evaporation, although there is probably not enough difference in evaporation to show in the tests outlined. There is no doubt, for instance, that mineral oils, such as kerosene or gasoline, have much less killing power than the lubricating oils of higher viscosity and lower volatility, and it is worthy of note in this connection that successive dilutions of lubricating oils with fuel oil, such as are shown in Table 6, considerably lower the toxicity. With this in mind it seems clear that oils of high evaporation and low viscosity should depend for their killing power largely on other materials contained therein or added thereto, rather than on the oils themselves.

The idea that viscosity is the main factor in the oil composing an emulsion that influences toxicity for red mite eggs, is substantiated by results shown in Table 5. It is difficult to explain the differences in the oils from different sources though it seems probable that differences in emulsifying properties may have played an important part. At any rate it is clear that with oils from the same source, those having higher viscosities were most effective.

Tests were made with two stabilized oil emulsions with lime-sulfur added and these seemed to indicate that the added lime-sulfur slightly increased the toxicity for red mite eggs.

Preliminary tests were also made in 1929 with oils emulsified differently and showing different sized globules when examined microscopically. These data are given in Table 7. The results seem to indicate that those showing the larger oil globules when exam-

ined microscopically offer the best killing agent. The more imperfectly an oil is emulsified, the larger the oil globules in general are found to be. Consequently, it seems justifiable to assume that stabilization, which usually reduces the size of the globules, also reduces its killing power. This is substantiated by the performance of commercial stabilized emulsions, which give as a rule no better kill of mite eggs than miscible oils and not so good as the homemade preparations that we have tried. However, in previous experiments where stabilization was accomplished by addition of casein, glue or gum arabic, conflicting results were obtained and further study of this phase of the question seems desirable.

In conclusion, it seems from our experiments that:

1. Heavier oils are more effective than light, when emulsified on the same formula.

2. An emulsion with large oil globules is slightly more effective than one with small globules. The differences obtained are, however, doubtfully important.

3. Fuel oil added to lubricating oils lowers their toxicity for red mite eggs.

4. Oils dissolved in gasoline may be used to compare different oils of the same or different properties.

5. There is some indication that addition of lime-sulfur to stabilized emulsions increases the kill.

TABLE 4. ANALYSES AND PHYSICAL CONSTANTS OF OILS

No.	Name	Unsulfonatable residue %	Sp. Gr. 20° C.	Saybolt Vis. 100° F.	Evaporation 60°-65° C.	Cold test
6710	XCIV (A) Sunoco Golden	77.8	0.9450	433.8 sec.	1.69%	14° F.
6711	XCV (B) Sunoco Golden	75.0	0.9518	652.0	1.58	43°
6713	XCII Sunoco Golden	76.6	0.9395	195.7	2.44	—18°
6714	XCI Sunoco Golden	58.0	0.9254	103.2	5.08	—27°
6715	Aleph Oil	53.4	0.9313	291.2	2.88	21°
6716	No. 776 Oil	55.4	0.9230	704.4	1.93	41°
6717	Altair Oil	54.4	0.9342	463.2	2.05	18°
6718	Nabob Oil	54.0	0.9281	214.4	3.57	19°
6723	XXX Pale Spindle Oil	55.2	0.9257	168.8	3.88	—27°
6724	Socony Motor Oil—Medium	52.4	0.9129	443.3	0.85	16°
6725	Socony Motor Oil—Heavy	39.6	0.9148	915.4	0.73	18°
6726	Socony Motor Oil—Light	62.4	0.9073	291.4	1.26	10°
6727	No. 14 Spray Oil	56.0	0.9306	604.0	1.77	27°
6728	No. 910 Spray Oil	56.4	0.9280	472.7	1.69	16°
6729	Alcopol Oil	56.2	0.9201	222.2	3.22	7°
6730	XXV Sun Spindle Oil	51.2	0.9265	168.0	2.71	—20°
8214	Marcol	92.8		90.0	1.38	
8213	Acto	97.8		331.4	1.71	

TABLE 5. TESTS OF VARIOUS OILS EMULSIFIED ON A TWO PER CENT BASIS, FOR KILLING POWER FOR EGGS OF THE EUROPEAN RED MITE

Analytical number of oil	Viscosity	Hatch per cent
Socony lubricating oils, automobile		
6726	291	40.0
6724	443	13.7
6725	915	19.9 (poorly emulsified)
Sun Oil Co., lubricating oils		
6714	103	54.5
6713	195	51.0
6710	433	47.5
6711	652	20.0
Texas Co., oils		
6718	214	31.0
6717	463	17.6
Gulf Refining Co., oils		
6729	222	19.0
6728	472	15.7
6727	604	14.8
Standard Oil Co., white oils		
8213	90	14.9
8214	331	4.8

Formula: 75 cc. oil
25 cc. water
2 gms. sodium oleate powder

Diluted 10.6 to 400 cc. water

TABLE 6. EFFECT OF ADDING FUEL OIL ON THE KILLING POWER OF A LUBRICATING OIL; TWO PER CENT EMULSION

Analytical number of oil used	Per cent fuel oil	Dates of treatment and exam.	Total eggs	Number hatched	Per cent hatched
6715	50	3/1–5/16	123	30	24.6
6715	33	3/1–5/16	259	56	21.6
6717	25	3/1–5/16	507	59	11.8
Check		3/1–3/16	77	43	55.5

TABLE 7. TESTS OF KILLING POWER OF DIFFERENT OILS, DISSOLVED IN GASOLINE, ON THE EGGS OF THE EUROPEAN RED MITE; ONE PER CENT LUBRICATING OIL USED[1]

Analytical number of oils used	Viscosity	Average per cent hatched	Total number counted	Dates of treatment and exam.
6711	652	9.8	322	4/23–5/16
6710	433	4.7	347	4/23–5/16
6714	103	29.7	256	4/23–5/16
6716	704	6.0	292	4/23–5/16
6718	214	6.8	487	4/23–5/16
6723 } 6730 }	168	19.5	739	4/23–5/16

[1] Laboratory tests. Sprayed and kept in jars over saturated salt solution.

TABLE 7—*cont.*

Check—no treatment	81.5	161	4/23–5/16
Gasoline only	58.5	326	4/11–4/23–30
Check—no treatment	70.5		4/11–4/23–30

TABLE 8. COMPARISON OF TWO OILS DISSOLVED IN GASOLINE, THE OILS HAVING THE SAME VISCOSITY BUT SLIGHTLY DIFFERENT PROPERTIES[1]

Viscosity of oil	Total eggs used	Number of tests	Average per cent hatched
168	2153	13	34.0
168	3339	20	32.9
Gasoline only	1204	8	46.4
Check—no treatment	1305	10	61.3

TABLE 9. EFFECT OF VISCOSITY ON KILLING POWER OF OILS, 1929[2]

Analytical number of oil	Viscosity	Number of eggs	Number of tests	Per cent hatched
6714	103	3637	23	15.7
6713	*195*	*851*	*6*	*11.8*
Check—no treatment		1390	9	35.0

TABLE 10. COMPARISON OF UNSTABLE EMULSION FORMING A FILM ON SURFACE QUICKLY, WITH STABILIZED EMULSION IN WHICH SEPARATION IS DELAYED[1]

Number of eggs used	Number of tests	Per cent hatched	
1423	*9*	*1.6*	*Unstable: Visc. 200, 2% oil*
1520	9	4.1	Stabilized: Visc. 100, 2% oil, April 4
1125	7	8.5	Stable: Visc. 100, 3% oil, March 14
1114	*8*	*7.7*	*Unstable: Visc. 100, 3% oil, March 14*
464	5	59.0	Check—no treatment

TABLE 11. COMPARISON OF EMULSION WITH LARGE OIL GLOBULES WITH ONE HAVING SMALLER GLOBULES[1]

Number of eggs used	Number of tests	Per cent hatched	
990	6	3.9	Unstable: Globules 5-8 μ, few below 5 μ, oil visc. 100
1090	7	4.8	Stabilized: Globules .8 μ-6.8 μ, none above 6.8 μ, mostly below 5, visc. 100
841	5	60.5	Check—no treatment

TABLE 12. SHOWING EFFECT ON RED MITE EGGS OF ADDING LIME-SULFUR TO TWO COMMERCIAL STABILIZED EMULSIONS

Oil	Oil content	Lime-sulfur dilution	Number eggs used	Number tests	Per cent hatched
A	4%	None	1504	10	4.2
A	4%	1–50	1554	10	3.0
B	4%	None	1979	10	3.8
B	4%	1–50	1265	10	.55

[1] Sprayed and hung outside exposed to the weather.

[2] Sprayed and hung outside exposed to the weather. 1.5 per cent oil. Emulsified with sodium oleate plus casein, using the same formula for each. Higher viscosities gave no better results than the 195 sec. oil in this test.

EXPERIMENTS WITH OILS ON A DOUBLE INFESTATION OF APHIDS AND EUROPEAN RED MITES AT THE EXPERIMENT FARM AT MOUNT CARMEL

Philip Garman

An opportunity to try different combinations for control of aphids[1] and red mites was afforded in 1929 by a double infestation of the two species at the Experiment Station Farm. In addition to field tests in which a number of large trees were treated with each material, eggs were clipped from the trees, sprayed in the laboratory and hung outside. Counts were made first of the number of eggs hatching, second of the per cent killed on the trees and finally of the number of colonies of aphids establishing themselves. Counts were also made of red mites and the number of spurs becoming infested. Two brands of oil were used, a heavy miscible oil and a commercial emulsion with ammonium caseinate.

At the time of the application, the leaves of Greening and Baldwin were well advanced, and in consequence some burning occurred, especially with the oil emulsion, though this was not serious with any of the mixtures. In addition to the two oils alone, the emulsion was combined with free nicotine and nicotine sulfate and the count showed considerably improved results with these combinations for aphis control over the oil alone. The oil plus lime-sulfur seemed to increase the leaf burning, although no serious harm resulted and there was a good crop of fruit on these trees. The commercial oil was also combined with freshly made Bordeaux with good success from the standpoint of spray injury, there being little or no injury and the trees recovering promptly. The Bordeaux mixture was made by dissolving copper sulfate, pouring the material into the tank and filling it to about two-thirds capacity, then slaking granular lime[2] on the strainer and washing this into the tank. The oil was then emulsified in a small amount of water and added to the tank. The oil lime-sulfur combination was not so successful and considerable sludge settled to the bottom.

The best control of aphids was obtained with the lime-sulfur and nicotine-sulfate spray, Table 14, the combination of oil and nicotine, either sulfate or free nicotine, ranking next. Very little difference could be seen in the two latter combinations, which differ somewhat from the New Jersey results, but may be explained by the fact that the oil used contains considerable free ammonia, which probably acts on nicotine sulfate to free the nicotine rapidly, thus making this combination essentially the same as the oil and free-nicotine mixture. The miscible oil showed considerably greater kill than the commercial oil emulsion, but less than oils plus nicotine. Unfortunately there were few or no

[1] Mostly green aphids, *Aphis pomi* De G.
[2] Difficult to slake by this method in cold weather.

aphids on the trees sprayed with lime-sulfur and oil or Bordeaux and oil so that corroboration of laboratory results particularly with oil-lime-sulfur, as given in Table 13, could not be obtained. The various oils are ranked in the order of the best kill for aphids in Table 15.

TABLE 13. RESULTS IN CONTROL OF APHIS ON APPLE, 1929[1]
Tests to Kill the Eggs

Materials	*Dilution*	*Per cent killed*
Lime-sulfur Nicotine sulfate	1–10 1–400	97.5
Oil (emulsion) Lime-sulfur	4–100 1–100	88.8
Oil Free nicotine	4–100 1–800	67.3
Oil Nicotine sulfate	4–100 1–800	65.2
Oil without nicotine or lime-sulfur	4–100	64.3
Check—no treatment—sprayed clear water		43.3

TABLE 14. COUNT OF APHIDS ON SPRAYED APPLE TREES

Materials used	Dilution	Per cent aphis infested spurs
Lime-sulfur .... Nicotine sulfate	12 gals.–100 gals. 1 pint – 50	7
Oil emulsion .... Nicotine sulfate	5 gals.–100 1.5 pints–100	22
Oil emulsion .... Free nicotine	5 gals.–100 1.5 pints–100	26
Miscible oil	4 gals.–100	27
Miscible oil .... Bordeaux	4 gals.–100 8–8 lbs. –100	39
Miscible oil .... Lime-sulfur .... Casein lime	4 gals.–100 3 gals.–100 3 lbs. –100	43
Oil emulsion	5 gals.–100	54
Check	No treatment	58

TABLE 15. VALUE OF SEVERAL DIFFERENT TREATMENTS COMPARED IN ORDER[2] FOR KILL OF APHIDS

	Kill of eggs	Kill of aphids in field	Infestation of fruit spurs	
1	LS—N.S.	LS—N.S.	LS—N.S.	
2 3	Oil—Free N. Oil—N.S.	Oil—N.S. Oil—Free N.	Oil—N.S. Oil—Free N.	very close in all tests
4 5	Oil only	Miscible oil Oil emulsion	Miscible oil Oil emulsion	approximately the same in field tests
6	Check	Check	Check	

[1] Mostly green apple aphis (*A. pomi*). A few rosy aphis. Eggs treated in laboratory and hung outside.
[2] Omitting oil Bordeaux and oil-lime-sulfur sprays. No. 1, best; 2 next; 3, next, etc.

TABLE 16. SUMMARY OF RESULTS IN SPRAYING EXPERIMENTS FOR CONTROL OF APHIS AND RED MITES IN A COMBINED INFESTATION AT MOUNT CARMEL, 1929

Materials	Dilution	Per cent[1] aphis killed	Per cent[2] spurs infested with aphids	Per cent[3] red mites killed	Per cent[4] spurs infested by red mites
Lime-sulfur ... Nic. sulfate ...	12 gals.–100 gals. 1 qt. –100	75	7	Few or no E. red mites on these trees at the beginning	
Oil emulsion .. Free nicotine ..	5 gals.–100 1.5 pints–100	59	26	96.3	33
Oil emulsion .. Nic. sulfate ...	5 gals.–100 1.5 pints–100	64	22	92.4	17
Miscible oil ...	4 gals.–100	44	27	Few or no E. red mites on these trees at the beginning	
Oil emulsion ..	5 gals.–100	44	54	88.1	39
Miscible oil ... Lime-sulfur ... Casein lime	4 gals.–100 5 gals.–100 3 lbs. –100	42	43	91.4	12
Check		35	58	30.5	99

NOTES ON LIFE HISTORY AND CONTROL OF THE PINE LEAF SCALE

Neely Turner

The pine leaf scale, *Chionaspis pinifoliae* Fitch, is a pest of considerable importance on young pine trees in Connecticut. Heavily infested seedlings grow slowly, lose much of their foliage, and are killed if the attack persists. Older trees growing in shaded locations are also very susceptible to attack and are sometimes seriously injured. Infested foliage becomes light in color, and the trees are very sickly in appearance, even when the infestation is comparatively light. The pine leaf scale attacks many species and varieties of pine, and has been recorded as attacking spruce in other states. However, there are no Connecticut records of this insect on spruce. It is also found on hemlock, *Tsuga canadensis,* when grown both as trees and as hedges. Infested hemlock hedges lose foliage badly, and occasionally branches are killed. Illustrations of this insect are shown on Plate XXIV.

Although this is a very common insect, very little work on life history and control has been done. Earlier notes on the subject almost uniformly stated that there were two broods a year, and suggested kerosene emulsion as a control. Later publications call attention to the use of dormant oil and lime-sulfur sprays. The

[1] Counted on twigs removed from the trees and brought to the laboratory.
[2] Counted in the field; more than 1,000 spurs examined for each treatment.
[3] Twigs clipped off and counted in laboratory with microscope.
[4] Counted in field, using only spurs with eggs on them or at their bases.

most recent study was published by Herrick, who found that in central New York the pine leaf scale has but one brood a year. He suggested the use of oil sprays applied after the crawlers had hatched, as a control measure.

The following notes on life history and control of this insect were made at New Haven during 1929. All observations were made on young Scotch pines, *Pinus sylvestris,* six years from seed. These seedlings are planted in the open and not shaded.

There were two distinct broods of this insect in 1929. Crawlers from the over-wintering eggs first appeared on May 18 and a majority of the eggs hatched during the succeeding week. Very soon after hatching, the crawlers settled down and started feeding. A few days after feeding began, the young larvae changed in color from the dark red of the newly hatched crawlers to a straw color. The bodies increased in size rapidly, but molting did not begin until June 12. Thus the young larvae remained unprotected for a period of about three weeks. The first brood matured early in July and by July 10 practically all the second brood eggs were laid. Two weeks later, a few second brood crawlers appeared, but all the eggs did not hatch until August 12. At this time, many of the young larvae had already molted. The over-wintering eggs were deposited during the first half of October. There was no indication that any of the first brood eggs carried over until fall.

Control Measures

Dormant applications of liquid lime-sulfur or miscible oil have been recommended frequently for control of this pest. However, the insect is very resistant to sprays at this time, the eggs being well protected by the covering of the old female scale. Oil sprays at two per cent actual oil content applied April 29 failed to give good control. Approximately 40 per cent of the eggs were killed, the natural mortality being about 10 per cent. The oil used was a laboratory preparation—a soap emulsion of a white oil.

The comparatively long period of time between hatching of the first brood eggs and the first molt, first noted by Herrick, suggested contact insecticides for control at this time. Accordingly, tests were made, using oil sprays and commercial 40 per cent nicotine sulfate with soap. The oil spray was a laboratory preparation containing one per cent white oil emulsified with soap. The first application was made May 18, before all the eggs had hatched. Most of the larvae and a few of the eggs were killed by this spray. A second application, May 25, effected a more complete control. Applications of 40 per cent nicotine sulfate, diluted one part to 500 parts water with one per cent soap flakes, were made on May 20 and 25. These sprays also gave good control, killing all of the crawlers, but very few of the eggs.

In both cases, the first application was made before all the overwintering eggs had hatched and therefore complete control was not obtained by the first spray. It is believed that the second application was much more important than the first. The trees in this experiment remained free from insect injury without further treatment. No injury was noticed from the oil application.

Spray tests were also made on second brood larvae, although the prolonged period of hatching of this brood makes control difficult. A commercial white oil spray was used at one per cent actual oil content. This oil was a low-viscosity white oil, about 60 seconds Saybolt. Application was delayed until July 26, at which time about half the eggs had hatched. This one application gave very good control, all the crawlers being killed and most of the unhatched eggs as well.

Nicotine sulfate was applied at one part to 500 parts water with one per cent soap, July 26 and August 3. These sprays killed the young crawlers, but did not affect the unhatched eggs. A third spray was not applied, but would have been necessary for complete control.

Oil Sprays on Evergreens

Summer oil sprays have not been tested extensively on evergreens, and should therefore be used with caution. No injury resulted from the experimental applications made in this test, but injury to evergreens has been reported from other states. A few precautions should be taken into account in applying oil sprays to evergreens. Only sprays made from highly refined (white) oils should be used during the growing season. Oil sprays should not be applied during excessively hot weather or during drought.

Recommendations for Control

Wherever possible, all sprays to control this insect should be made on the first brood. Nicotine sulfate, one part in 500 parts water with one per cent soap, or white oil at one per cent should be applied about June 1 in southern Connecticut. This date varies with location and seasonal differences. However, the red crawlers are very easily seen, and spraying can be timed about ten days after they first appear. If sprays for the second brood are desired, one application of a white oil at one per cent, or two applications of nicotine sulfate, one part in 500 parts water, with one per cent soap, should be made. In southern Connecticut the oil spray should be applied about August 1, and the nicotine sprays about August 1 and August 15. Based on appearance of the crawlers, the oil spray or first nicotine spray should be applied about a week after the first crawlers appear, and the second nicotine spray two weeks after the first application.

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THE MEXICAN BEAN BEETLE IN CONNECTICUT

***Epilachna corrupta* Mulsant**

A new pest of vegetable crops has appeared in Connecticut in the Mexican bean beetle, *Epilachna corrupta* Muls., which was discovered in July in the western portion of the state by Dr. E. P. Felt, Director of the Bartlett Tree Researcb Laboratories, at Stamford. The presence of this pest in the state was brought to the attention of the writer in a letter received from Doctor Felt on July 15. On July 23, the writer visited the Bartlett Laboratories in North Stamford and saw specimens of this insect and its injury in a bean patch near the Laboratory.

Present Distribution in Connecticut

Thus far, the insect bas been noticed only in the western half of the state; it has been observed in Fairfield, New Haven, Litchfield and Hartford Counties.

The first records were received from Doctor Felt; then specimens were received from correspondents. Members of the department staff observed the insect in two towns and finally Mr. Rodney Cecil, of the Bureau of Entomology, made a hurried trip through a portion of the state and discovered the pest in a half dozen localities. These localities, with date and name of the observer, are given below:

Fairfield County:
- Brookfield, July, E. P. Felt
- Darien, July 26, B. H. Raymond
- Monroe, Aug. 9, R. C. Botsford
- New Canaan, July, E. P. Felt
- Ridgefield, July, E. P. Felt
- Sherman, Aug. 1, C. L. Johnson
- Stamford, July, E. P. Felt
- Westport, July, E. P. Felt
- Wilton, July, E. P. Felt

Litchfield County:
- Canaan, Sept., R. Cecil
- Salisbury, Sept., R. Cecil
- Washington, July, E. P. Felt

New Haven County:
- Meriden, Sept., R. Cecil
- New Haven, Sept., R. Cecil
- Orange, Aug., R. B. Friend
- Wallingford, Sept., R. Cecil

Hartford County:
- Hartford, Sept., R. Cecil

In all the localities mentioned above, the infestations were light with only slight feeding upon the leaves. Mr. Cecil expressed his opinion in a letter to the effect that these "infestations originated from a few scattered egg-masses probably from migrating adults this Spring."

Mr. Zappe and his men were requested to watch for this insect on bean patches when traveling about the state inspecting nursery stock, but the pest was not discovered in any other towns in Connecticut.

History in the United States

Mexico is believed to be the original home of the Mexican bean beetle, but the insect has been known to be present in the southwestern part of the United States for more than 75 years. It now exists in Arizona, Colorado, New Mexico, western Texas, and Utah. In 1920 this insect was discovered in northern Alabama, and is thought to have been introduced in shipments of alfalfa hay from the West during the World War.

From Alabama, the Mexican bean beetle has spread chiefly northward and eastward until it now occupies Tennessee, Kentucky, Indiana, southern Michigan, southern New York, and all territory between these and the Atlantic Ocean. Southward it has spread more slowly; and now covers the upper two-thirds of both Alabama and Georgia, nearly all of South Carolina and the northeastern corner of Mississippi. Isolated infestations have been discovered in southern Georgia near the Florida line and at six points in Ontario, Canada, north of Lake Erie and Lake Ontario.

Injury to Plants

The plants are injured because the leaves are partially devoured by both larvae and adults; the feeding is chiefly from the under side. The adults generally feed upon the lower surface in ragged areas, but often eat through the upper surface. The larvae have the habit of feeding in small definite areas, eating narrow, nearly straight, parallel channels close together with a thin ridge of tissue between, and leaving the upper surface intact. These channels and ridges reach across the small area, and may be parallel with, perpendicular to, or at an angle, in relation to adjoining areas. In other words, the ridges do not all run in the same direction; some of them run in the same direction as the principal veins, and others are perpendicular to them. Between, there are all possible gradations in direction. This injury, therefore, presents a very characteristic appearance, as shown on Plate XXII, and could hardly be mistaken for the work of any other insect. Where the insects are abundant, bean plants are soon destroyed.

Food Plants

The Mexican bean beetle feeds upon the leaves of beans, preferring the common garden and field bean and the Lima bean to other plants. It will attack and injure all varieties of pole and bush beans of the genus *Phaseolus*. As a second choice, it will subsist upon the wild beggar-weed or beggar-ticks, *Meibomia* sps., cowpea, soy bean, hyacinth bean, alfalfa, and sweet clover.

Importance as a Pest

This insect is a serious pest of beans in the greater portion of this area in the eastern states. It is possible that the insect has about reached its northern limit; that it may not continue its rapid spread northward, and that it may not multiply as rapidly or do as much damage in Connecticut as in other states further southward. It is reported that the spread of the Mexican bean beetle in Michigan in 1929 was insignificant.

Description and Relationship

The adult beetle is about one-fourth of an inch long, longer than broad, and has the smooth, hard, hemispherical shell characteristic of the lady beetles, family Coccinellidae, to which it belongs. In color it is pale brown or buff and each wing cover bears eight black spots, which vary considerably in size and shape. In certain specimens the spots are so large that they almost coalesce. On emerging, the beetles are lemon yellow, but graduaally darken until they become copper color. In size, they are smaller than the squash lady beetle, *Epilachna borealis* Fabr., and have smaller spots. The thorax of the Mexican bean beetle is unmarked and that of the squash lady beetle is spotted.

The eggs are laid in masses of 40 to 60 on the under sides of the leaves. They are small, about one-twentieth of an inch long and orange in color. The larvae, when fully grown, are about one-third of an inch long, orange in color and covered with long branched spines. The pupae are about the same size as the beetles, yellow, and are attached to the leaf or other object upon which they pupate, the cast larval skin with spines covering the last abdominal segments.

The Mexican bean beetle, *Epilachna corrupta* Muls., and the squash lady beetle, *Epilachna borealis* Fabr., are the only lady beetles in Connecticut that feed upon cultivated plants and are injurious. All other species prey upon small insects and are considered beneficial.

Natural Control Agencies

Several native insects feed upon the eggs and larvae of the Mexican bean beetle. One of these is the spotted lady beetle,

Ceratomegilla fuscilabris Muls., which eats both the young larvae and eggs. The "anchor bug," *Stiretrus anchorago* Fabr., in both the nymph and adult stages, feeds upon the larvae, pupae and adults. The spined soldier bug, *Podisus maculiventris* Say., attacks the bean beetle in all its stages. The insects mentioned above all occur in Connecticut and are the chief insects that prey upon the Mexican bean beetle, though there are other lady beetles and other bugs which sometimes feed upon it.

Two species of two-winged flies occurring in Connecticut have been reared in Alabama as parasites of the Mexican bean beetle, *Phorocera claripennis* Macq., and *Helicobia (Sarcophaga) helicis* Towns., and a third species, *Paradexodes epilachnae* Ald., is a prevalent parasite in certain sections of Mexico.

Artificial Control Measures

As a means of control for the Mexican bean beetle, spraying or dusting has proven the most successful. Calcium arsenate seems to be more effective than lead arsenate and has been generally recommended by those who have gained experience in controlling the pest. One of the most satisfactory remedies is to dust the plants with calcium arsenate or magnesium arsenate, using one pound of the dry poison in four pounds of hydrated lime. Another formula is calcium arsenate, one pound, fine dusting sulfur, one pound, and hydrated lime, four pounds, using from 12 to 15 pounds per acre. Sodium fluosilicate, one part in two parts of lime, may also be used as a dust. As a spray, magnesium arsenate, one pound in 50 gallons water, has given good results when applied at the rate of about 100 gallons per acre. On string or snap beans where the pods are to be eaten, it is advisable to spray with a pyrethrum-soap preparation, following the directions on the package.

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FULLER'S ROSE BEETLE IN CONNECTICUT

***Pantomorus godmani* (Crotch) = *Aramigus fulleri* Horn**

On September 5, Mr. Johnson of this department brought to e office some weevils from a greenhouse in Norwalk. These etles were upon the blossoms of *Acacia,* and were said to have en notches in the leaves of the *Camellia,* several varieties of ich were growing there.

These beetles were identified by Mr. Walden as Fuller's rose etle, *Pantomorus godmani* (Crotch), a species formerly listed *Aramigus fulleri* Horn, and considered a pest of roses and some ier plants. Some of the books and bulletins of a generation o contain accounts of this insect. Smith's "Insects of New rsey" in reference to this insect contains the following statent: "An imported species, which was for a time a serious pest rose-houses in Union County and elsewhere. It was never undant outdoors and is rarely found now, even in greenhouses, ere they have learned to deal with it."

Later, some curculionid larvae were dug from the soil in the ne greenhouse in Norwalk and brought to the Station, but at s writing, no adults of Fuller's rose beetle have been reared om them. The only adults so far obtained are the black vine evil, *Brachyrhinus sulcatus* Fabr.

Distribution, Food Plants and Habits

According to Doctor Chittenden,[1] this insect occurs over the greater portion of the United States and Canada. In the northern range it appears in greenhouses, but in California it is known to live out of doors. The food plants recorded are as follows: abutilon, achyranthes, alfalfa, apple, apricot, azalea, common and Lima beans, begonia, blackberry, camellia, canna, cape jasmine, carnation, cissus, citron, chrysanthemum, currant, deutzia, dracaena, fuschia, geranium, golden glow, grapefruit, hibiscus, leadwort, lilies, lemon, oaks, orange, palms, peach, pear, pentstemon, persimmon, plum, plumbago, prune, primrose, potato, raspberry, roses, scabiosa, strawberry, sugar cane, tangerine and vinca.

Apparently roses, especially tea roses, are preferred with geranium a second choice. In California it occasionally causes injury to lemon groves, and the larvae feed upon the roots of blackberries, loganberries, raspberries, roses and strawberries.

The beetles feed at night, and during the day rest in places where they are not readily observed, usually among the leaves of their food plants, but sometimes clinging to the twigs or hiding under the plants. They are active at night, but they have no wings and cannot fly; hence, they must crawl up the stems to reach the leaves. When disturbed, they fold their legs and antennae and drop to the ground after the manner of the plum curculio and many other weevils. As they do not move for some time and are inconspicuous in color, they readily escape notice.

Life History

The female lays eggs in crevices or under the edges of loose bark near the ground, in flattened batches containing from 10 to 60 eggs arranged in several contiguous rows. Sometimes the eggs are deposited between the soil and the main stem. These eggs adhere together firmly. They hatch in about a month, and the larvae live in the soil, where they feed upon the roots of plants. The length of the larval stage has not been definitely determined but probably occupies a month or more and varies considerably, according to the conditions under which the insect exists. In fact, it is said that all stages may be found during the winter and early spring, but that the individuals are most noticeable in December.

Description

The adult beetle varies from a quarter to three-eighths of an inch in length. The snout is short and scarred at the sides of the mandibles. Head, thorax and abdomen are brown, more or less covered with gray scales. These scales are somewhat lighter on

[1] F. H. Chittenden, Division of Entomology, Bull. 27 (new series), 88. 1901.

the head and thorax and browner on the abdomen. The abdomen is oval, longitudinally ribbed or striated, and with a diagonal patch of light gray scales near the outer margin of each wing-cover, about half-way between the base and apex. Legs and antennae are nearly uniform in color with the thorax and abdomen. See Plate XXVI, a.

Methods of Control

It is said that the beetles live a long time and are very resistant to the usual insecticides. Even hydrocyanic acid gas has little effect on them at a concentration that is safe for the plants. Persistent searching for the beetles and killing them, during the months of November and December, greatly reduces the number of the insects and has practically eradicated the pest from many greenhouses. Another measure of control is to kill the larvae and pupae by treating the soil with carbon disulfide or an emulsion of carbon disulfide. As the beetles are wingless, they must necessarily crawl up the stems to gain access to the leaves, and this fact may be taken advantage of to protect the plants by placing around the stems, barriers of cotton, card collars, or tanglefoot to prevent the beetles from ascending the plants.

Essig recommends spraying the foliage with lead arsenate, two pounds of the dry powder in 50 gallons of water, where the bands cannot be used.

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AN OUTBREAK OF SMALL AQUATIC FLIES IN A FILTER PLANT

B. H. Walden

At the request of Mr. C. P. Prann, city engineer of Meriden, a visit was made July 30 to the filter plant of the Meriden Water Company at South Meriden, where swarms of small non-biting

flies were causing trouble in the control room. The plant was operated at night because the electrical power could then be obtained at a reduced rate. The insects were attracted to the lights and had badly spotted the black panels of the instrument boards, as well as the white walls of the room. They were also very annoying to the operator in charge of the plant. In the morning, a pint or more of these flies could be swept from the floor under the lights. Screens had been put in the windows, but the flies readily came through the mesh and many that would naturally fly out again were held in by the screens, so that there were probably more flies inside in the morning than there were before the screens were put on.

A few larvae and pupae were present in the water in the filter beds and adults were emerging in the coagulating tanks where the water was received before it passed to the filter beds. It was evident from the method of handling the water that it did not remain long enough for the flies to breed in either place.

The reservoir, about 1,000 feet away, was then examined. Many larval and pupal skins were floating on the surface of the water near the edges. Although it was quite evident that the flies were breeding in the reservoir, it was not determined why they were so much more abundant than in any preceding season. There had been a lack of rain, but the water level was within a foot of normal. It was suggested to try suction fans near the electric lights to rid the control room of them.

Some of the flies were collected and found to represent two species; these were sent to Professor O. A. Johannsen, of Cornell, who determined the species as *Chaoborus punctipennis* Say. and *Chaoborus trivittatus* Loew, of the family Culicidae. The former, a spotted species, was very abundant, but the latter formed only about four or five per cent of the total number of flies.

THE JAPANESE BEETLE: SCOUTING AND QUARANTINE ENFORCEMENT

W. E. Britton and J. Peter Johnson

In 1929, the work of controlling the Japanese beetle in Connecticut has been carried on as a coöperative project by this department and the Federal Plant Quarantine and Control Administration. This work has consisted of (1) soil treatment to kill the grubs, (2) trapping and scouting for beetles, and (3) quarantine enforcement.

Mr. Johnson has been in immediate charge of all this work and the report in detail has, for the most part, been prepared by him.

Soil Treatment

From numerous diggings in the localities where Japanese beetles were found in 1928, it was ascertained that grubs were present in the soil. Therefore, it was deemed best to treat these areas both in Hartford and New London in an attempt to kill the grubs before they could transform and emerge as beetles. With Federal coöperation, this work was carried out between May 31 and June 8. A quantity of prepared standard carbon disulfide emulsion was purchased. This emulsion was diluted at the rate of 1.2 quarts in 50 gallons water and applied by means of an automobile truck spray outfit. Treated areas are shown on Plate XVIII.

In Hartford eight men working six days treated an area of 107,200 square feet of lawn surface, using 40,200 gallons of diluted emulsion. In New London, seven men in two days treated 27,200 square feet, using 10,200 gallons. These figures are shown in the following:

Place	Date	Diluted emulsion applied (gallons)	Area treated sq. ft.	No. men
Hartford	May 31–June 6	40,200	107,200	8
New London ..	June 7–8	10,200	27,200	7
Total		50,400	134,400	

Scouting

The scouting activities in Connecticut began on July 8, 1929, when 29 men reported at the Shelton office ready for work; in the next few days, five more men reported, making 34 men in all, in addition to the scout supervisor. These men were taken to Bridgeport, where they were trained by the supervisor and two other men who are permanently connected with the project. They remained there for several days until the supervisor was satisfied that they were qualified for scouting. They were then divided into seven field scouting crews of four men each, and two greenhouse scouting crews of three men each. Each crew was then assigned a definite territory and work began in the following localities: a crew each in Hartford, Manchester, Meriden, New Britain, New London, Wallingford and Willimantic. The state had been divided into approximately 16 areas, each area being of such a size that it was possible for the field scouting crews to cover the entire ground without being removed from their headquarters. Upon completing one area, the crew was moved to another and in this way the work was carried on more efficiently and with the minimum waste of time in travel. The supervisor visited the crews daily, assigning the areas to be scouted and checking over the work performed. It was also his duty to see that all records of scout work were completed properly, and he kept close contact between the headquarters office and the various crews.

The greenhouse scouts inspected all classified establishments within the regulated area. In order to do this, the men were divided into two crews of three men each and a motor car was assigned to each crew. One crew was sent to the regulated area in Fairfield County, and the other to that area within New Haven County. The classified establishments and the routes were so arranged that each establishment was scouted twice every week during the entire season.

Throughout the season, scouting was also performed at various times in Bridgeport, Norwalk, New Canaan, New Haven and Stamford by farm products inspectors. This was done to enable the department to keep informed as to the increase in the degree of infestations at these places, also as to the possible spread of beetles from these established infestations.

There were 290 crew hours lost on account of rainy weather, though the rainfall was below normal, causing a dry and dusty condition throughout the season.

The areas scouted during the 1929 season included the following towns, villages and cities:

Berlin
Branford
Bridgeport
Bristol
Canaan
Cheshire
Clinton
Colchester
Collinsville
Cromwell
Danbury
Danielson
Deep River
East Hampton
East Hartford
East Windsor Hill
Enfield
Forestville
Guilford
Groton
Hartford
Hazardville
Lakeville
Litchfield
Lyme
Madison
Meriden
Middletown
Milldale
Manchester
Naugatuck
Norfolk
Norwich
New Britain
New Haven
New London
New Milford
Oakville
Plainville
Plantsville
Pomfret
Portland
Putnam
Salisbury
Saybrook
Southington
Stafford Springs
Stamford
Stratford
Stonington
Suffield
South Manchester
Terryville
Thomaston
Thompsonville
Torrington
Wallingford
Waterbury
Watertown
Warehouse Point
Westbrook
Westerly, R. I.
West Hartford
Willimantic
Windsor
Windsor Locks
Winsted

In addition to the daily scouting for *Popillia japonica* Newn., *Anomala orientalis* Waterhouse, and *Aserica castanea* Arrow, night scouting was carried on for the *Aserica castanea* Arrow by the foremen of each crew. This work was carried on between the hours of 7:00 P. M. and 10:00 P. M., two and three nights a week as the weather permitted, each man carrying a flashlight. However, in this scouting no beetles were found.

The areas scouted at night during the 1929 season included the following towns and cities:

Bridgeport, Bristol, Canaan, Cromwell, Fairfield, Hartford, Middletown, Meriden, New Britain, New Haven, North Manchester, Putnam, Stafford Springs, Stamford, Torrington, Wallingford, Willimantic, Winsted.

Japanese beetle traps furnished by the Federal men were placed around the infestations of 1928, in Hartford and New London before the beetles emerged, and allowed to remain until September 15. Traps were placed in Willimantic and in additional localities in Hartford, as soon as possible after the beetles were discovered. The number of traps used in each place and the number of men required to attend them is shown in the following table:

City	No. of traps	No. of men
Hartford	750	3
New London	250	1
Willimantic	250	1
Total	1,250	5

Asiatic and Japanese beetles were found at the following places outside of the 1928 generally infested area.

HARTFORD

Address		Beetles found	Dates found
70 Fairfield Avenue	1	*Popillia japonica*	July 31
88 Fairfield Avenue	1	" "	July 31
603 Farmington Avenue	1	" "	July 31
107 Grandview Terrace	1	" "	July 31
115 Grandview Terrace	1	" "	July 31
125 Beacon Street	1	" "	Aug. 13
Ford and Asylum Streets	12	" "	Aug. 13
36 Bodwell Street	1	" "	Aug. 27
Total Hartford	19		

WILLIMANTIC

Address		Beetles found	Dates found
49 Maple Street	2	*Popillia japonica*	Aug. 5
7 Turner Street	1	" "	Aug. 5
17 Turner Street	1	" "	Aug. 3
13 Turner Street	2	" "	Aug. 3
13 Turner Street	3	" "	Aug. 5
Total Willimantic	9		

HARTFORD

In traps	*413*	*Popillia japonica*	*June 9 to Sept. 14*
Near traps	450	" "	June 9 to Sept. 14
Total Hartford	**863**		

NEW LONDON

In traps	95	*Popillia japonica*	June 9 to Sept. 14
Near traps	73	" "	June 9 to Sept. 14
Total New London	168		
In trap	1	*Aserica castanea*	June 9 to Sept. 14

WILLIMANTIC

In traps	4	*Popillia japonica*	June 9 to Sept. 14
Near traps	8	" "	June 9 to Sept. 14
Total Willimantic ..	12		

Total number of towns in which beetles were found 3

Total number of beetles found outside of generally infested area of 1928: *Popillia japonica*, 1,043; *Aserica castanea*, 1.

In all, 80 classified nurseries and greenhouses were scouted twice a week in the summer of 1929.

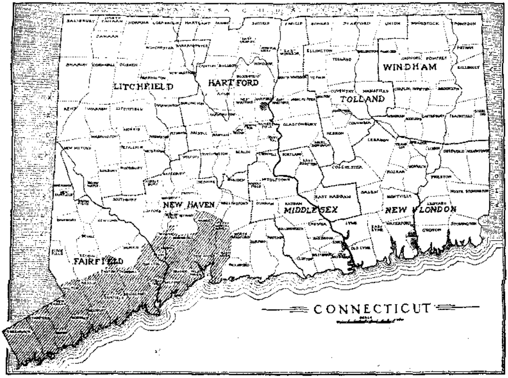


FIGURE 52. Map of Connecticut. Shaded areas indicate territory quarantined on account of Japanese beetle.

Quarantines

On account of the distribution of the beetle, Federal Quarantine No. 48 (Fifth revision) extends the Bridgeport area to include New Haven and surrounding towns. The state quarantine coincides with the Federal Quarantine (Figure 52), but places addi-

tional restrictions on certain areas in Hartford and New London, as shown in Figures 53 and 54. The quarantine order follows:

STATE OF CONNECTICUT

AGRICULTURAL EXPERIMENT STATION

NEW HAVEN, CONN.

Quarantine Order No. 20

CONCERNING THE JAPANESE BEETLE

The fact has been determined that the Japanese beetle, *Popillia japonica* Newman, has been found in the cities of New Haven, New London and Hartford, and to prevent the further spread of this pest it is necessary to extend the quarantine restrictions over certain additional areas regarding which a public hearing was held in New Haven, February 25, 1929. Federal Quarantine No. 48 has also been revised, effective February 15, 1929, to include eleven additional towns in New Haven County.

Now, therefore, I, William L. Slate, Director of the Connecticut Agricultural Experiment Station, under authority conferred by Chapter 31, Public Acts of 1927, do hereby proclaim the regulated area fixed by State Quarantine Order No. 16, and by the rules and regulations supplemental to Federal Quarantine No. 48 (Fifth Revision), effective on and after April 1, 1927, as amended effective on and after November 1, 1927, namely, the towns of Bridgeport, Darien, Easton, Fairfield, Greenwich, New Canaan, Norwalk, Shelton, Stamford, Stratford, Trumbull, Weston, Westport, and Wilton, in *Fairfield County,* to be extended to include the eleven towns of Ansonia, Derby, East Haven, Hamden, Milford, New Haven, North Haven, Orange, Seymour, West Haven and Woodbridge, in *New Haven County.*

Also, that that portion of the City of Hartford bounded by Farmington Avenue, Spring Street, Walnut Street, Sargeant Street, and Sigourney Street, is hereby quarantined.

Also, that that portion of the City of New London bounded by Huntington Street, Bristol Street, Williams Street, Manwaring Street, Hempstead Street, Franklin Street, Cottage Street, and Broad Street, is hereby quarantined.

The rules and regulations supplemental to Federal Quarantine No. 48 (Sixth Revision), effective on and after February 15, 1929, or any subsequent amendments thereto, restricting the interstate movement of quarantined articles from the regulated areas, are hereby declared to be in full force and effect with respect to the intrastate movement of quarantined articles from the herein designated regulated areas of Connecticut to unregulated portions thereof.

This order shall be effective on and after April 1, 1929.

W. L. SLATE,
Director, Connecticut Agricultural Experiment Station.

Approved:
JOHN H. TRUMBULL, *Governor.*

The foregoing quarantine order with maps and brief information about the Japanese beetle was published as Bulletin of Immediate Information 64, April 15, 1929, in an edition of 6,250 copies.

Inspection of Farm Products

In making a preliminary survey as to the market conditions in the shipping centers that would be affected by the Farm Products Quarantine, it was necessary to erect platforms in Bridgeport and

New Haven. It was also necessary to station a man in Norwalk, one in Stamford and have one ready at the Shelton office to take care of inspections. The platform at Bridgeport was located on Water Street, near the center of the market, and approximately ten by thirty feet, while the one in New Haven was located at 21 Lafayette Street, being similar in size. The New Haven platform was also located to advantage in the market. It was found,

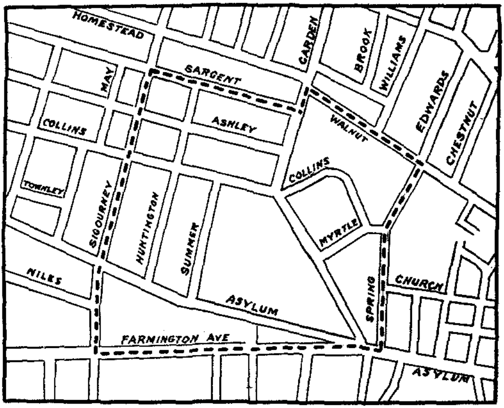


FIGURE 53. Map of section of Hartford. The dotted line surrounds area under State quarantine on account of Japanese beetle.

however, as the season progressed, that the size was inadequate and if conditions are similar in the coming year, it will be necessary to enlarge it somewhat.

The one foreman located at New Haven, in addition to his duties at the inspection platform, also took care of miscellaneous inspections that were made at other points from that section. Six inspectors were employed and the platform was open throughout the week from Sunday afternoon, 3 P. M. through Saturday until 5 P. M. As the New Haven market carried on most of its own business at night, it was necessary to have the majority of the men present at those hours. Only one man was at the platform during the daytime, from 7 A. M. to 3 P. M. Another inspector reported at 3 o'clock and was on duty until 11 P. M. At 8 P. M., a second

inspector reported and he made inspections at chain store headquarters for two or three hours every night because it was found to work out more efficiently. He generally returned to the platform about 10:30 or 11:00 o'clock and remained there until 4 A. M. At 11 P. M. two inspectors reported for work. Thus three men were present at the platform at the rush hours. These were from 11:45 P. M. to 2 A. M. and from about 4:30 A. M. until 7 A. M. The sixth man reported at 1 A. M. and worked

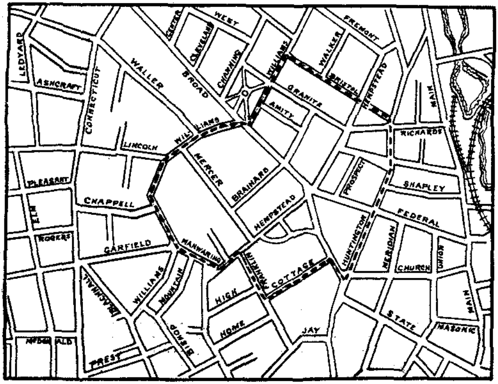


FIGURE 54. Map of section of New London. The dotted line surrounds area under State quarantine on account of Japanese beetle.

until 9 A. M. It was found that this schedule of the inspectors reporting for work took care of the inspections in an excellent manner.

The Bridgeport platform was open from 6:30 A. M. until 5 P. M. with the exception of Saturday afternoons and Sundays. One man reported at 6:30 A. M. and worked his eight hour shift; the other man reported at 9 A. M. On the busy mornings, which occurred Mondays, Thursdays and Fridays, the foreman reported at 6:30 A. M., thus giving adequate service to the shippers. When periods were slack during the day he checked the inspectors at Norwalk and Stamford and took care of miscellaneous inspections elsewhere.

One man was stationed at the Berman and Steinberg commis-

sion house, Norwalk, while the other man was located at the S. Cohen and Co. commission house at Stamford, by arrangement. These men reported at 6 A. M. and worked eight hours. All inspections requested in those sections were referred to one of the two men. On quiet days these inspectors scouted the known infestations and the area surrounding them, to determine the increase in number of beetles present and their possible spread.

The inspector at the Shelton office took care of all miscellaneous inspections and was used as an extra on heavy days at the New Haven platform.

1. *Inspection points, number of men employed, number of packages certified and number of beetles removed were as follows:*

Place	Period operated	Hours per day open	Number of men	Packages certified	Beetles removed
Bridgeport	June 17–Sept. 24	10½	3	54,577	0
New Haven	June 21–Sept. 24	24	7	474,297	1
Norwalk	June 18–Sept. 24	8	1	23,996	0
Stamford	June 18–Sept. 24	8	1	3,299	3
Shelton	June 15–Sept. 24	8	1	412	0
			13	556,581	4

2. The number of packages of fruit and vegetables, and cut flowers certified in the regulated area of Connecticut, 1929, and the number of beetles removed were:

Article	Number of packages	Number of beetles removed
Corn	10,853	0
Beans	43,794	1
Peas	12,475	0
Lettuce	43,049	0
Vegetables with tops	88,790	0
Misc. vegetables	142,670	0
Misc. fruit	180,934	3
Bunches bananas	34,016	0
Boxes cut flowers	827	0
Total packages	557,408	4

3. The number of bales of hay, straw and sphagnum moss certified for shipment from the regulated area of Connecticut during 1929 were:

Office	Bales hay	Bales straw	Bales moss	Total bales
Shelton	178	80	0	258

4. Roads posted with quarantine signs, 1929, 66.

5. During the farm products quarantine, a total of 22 men were employed in patroling the roads at the quarantine boundaries. See Plate XVII.

6. Number of vehicles carrying quarantined articles without certification.

Roads	June	July	August	September	Totals
Post Road at Branford	51	111	92	40	294
Middletown at North Haven	..	16	16	1	33
Meriden at North Haven	3	37	21	9	70
College Highway at Hamden	17	30	32	..	79
Bethany at Woodbridge	2	28	12	5	47
Waterbury at Seymour	9	14	26	13	62
Bethel-Easton	5	22	12	..	39
Wilton-Ridgefield	4	1	..	..	5
	91	259	211	68	629

7. Number of vehicles bearing quarantined articles intercepted at the quarantine line each month and the season total.

Roads	June 18-30	July 1-31	August 1-31	September 1-14	Totals
Post Road at Branford	242	1,558	1,597	403	3,800
Middletown at North Haven	..	*98*	*69*	*12*	*179*
Meriden at North Haven	8	962	1,153	249	2,372
College Highway at Hamden	48	500	641	114	1,303
Bethany at Woodbridge	22	387	295	77	781
Waterbury at Seymour	67	468	430	123	1,088
Bethel-Easton	53	280	292	..	625
Wilton-Ridgefield	..	123	91	18	232
	440	4,376	4,668	996	10,380

Inspection of Nursery and Ornamental Stock

1. Within the quarantined area are 119 classified establishments having 642,280 square feet of glass and 1,333 acres of nursery stock.

2. Plants certified for shipment each month.

Jan.	Feb.	Mar.	Apr.	May	June	July
70	299	85,812	110,082	89,952	155,270	48,162

Aug.	Sept.	Oct.	Nov.	Dec.	Total
15,536	19,738	18,630	37,162	4,888	585,601

3. Diggings to determine grub infestations in fields, frames, or treated plots.

During the spring and fall of 1929, men were employed in making diggings to establish the fact whether or not any of the Asiatic beetle grubs were present in nurseries within the state.

Grubs were found in nurseries in the following towns:

Township	No. of grubs, *Aserica castanea*
Cromwell	25
Manchester	10
Mansfield	1
New Canaan	2
Southport	2
Total grubs found	40

4. During the season of 1929, 28 classified concerns decided to drop their classification because all of their business was within the regulated area.

Sand, Soil, Earth, Peat, Compost and Manure

1. Car loads of sand and manure certified for shipment out of the regulated area of Connecticut, 1929.

Sand	Manure	Total
360.5	136	496.5

2. The number of certificates issued on shipments of sand and manure.

Material	'A'	'F'	'G'	Total
Sand	609	3	51	663
Manure	84	..	..	84
	693	3	51	747

Summary

1. Average number of men employed in each different branch of the quarantine work at Connecticut office, each month, during the year *1929*.

Shelton Office

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Scouting	0	0	0	0	0	0	20	29	8	0	0	0
Farm products	0	0	0	0	0	20	34	31	12	0	0	0
Nursery and greenhouse	2	2	2	4	20	17	8	10	8	21	20	5
Administrative	2	2	2	2	2	3	1	1	1	1	1	1
	4	4	4	6	22	40	63	71	29	22	21	6

2. Total number of each kind of certificates used on shipments of (A) nursery and ornamental stock, (B) sand, soil, peat, marl, etc., (C) manure, (D) hay and straw, (E) fruit and vegetables, and (F) cut flowers, in State of Connecticut from January 1 to December 31, 1929.

Kind	*Farm produce*	*Cut flowers*	*Hay and straw*	*Nursery and ornamental*	*Sand, soil peat, etc.*	Manure	Total
'A'	....	....	24	1,218	609	84	1,935
'B'	11,931	....	....	....	....	....	11,931
'C'	58	....	....	....	....	....	58
'D'	....	....	....	1,036	....	....	1,036
'E'	....	526	....	11,729	3	....	12,258
'F' blanks....	....	....	....	193	....	....	193
'G'	....	301	....	489	51	....	841
'H'	5,678	....	....	....	....	....	5,678
	17,667	827	24	14,665	663	84	33,930

3. Articles certified, and number of beetles removed, in the State of Connecticut, January 1 to December 31, 1929.

Total packages farm produce	556,581	Beetles removed	4
" boxes cut flowers	827		
" bales hay and straw	258		
" plants certified	585,601		
" C. L. *sand, soil, etc.*	*360.5*		
" C. L. manure	136		

4. Total certificates lost or unaccounted for, 116.
5. Violation of Federal regulations totalled 26 in 1929; one case was prosecuted. The state prosecuted and obtained convictions in two cases, one for moving soil and the other for taking farm products out of the quarantine area without having the articles inspected or certified.

THE ASIATIC BEETLE: QUARANTINE AND INSPECTION

The discovery and spread of the Asiatic beetle, *Anomala orientalis* Waterhouse, has been described in preceding reports of this Station as follows: 1922, page 345, Plate XIV; 1923, page 291, Plate XX; 1924, page 294, Plates XXIV and XXV; 1925, page 309, Plate XI; 1926, page 252, Plates VII-XII; 1927, page 288; 1928, page 743; Bulletin 304; Bulletins of Immediate Information, Numbers 52, 53, 62 and 65. Bulletin 304 is the most complete account of this insect ever published, and the reader is referred to it for information regarding structure, habits and life history. Bulletin of Immediate Information No. 62 is more convenient if one desires information concerning treatment of lawns to prevent injury from the grubs.

A Federal quarantine, No. 66, was established and made effective March 15, 1929, on account of the Asiatic beetle, *Anomala orientalis* Waterhouse, and the Asiatic garden beetle, *Aserica castanea* Arrow. At this time the latter was not known to occur in Connecticut, but the former was known to be present in New Haven and West Haven. After the required legal notice, a public hearing was held at the Station on February 25, 1929, and the following quarantine order was issued. It became effective April 1, 1929:

STATE OF CONNECTICUT

AGRICULTURAL EXPERIMENT STATION

NEW HAVEN, CONN.

Quarantine Order No. 22

CONCERNING THE ASIATIC BEETLE

The fact has been determined that the Asiatic beetle, *Anomala orientalis* Waterhouse, now occurs in the towns of New Haven and West Haven and it seems advisable to revise the regulations and the restricted areas. A public hearing regarding the matter was held in New Haven, February 25, 1929.

Now, therefore, I, William L. Slate, Director of the Connecticut Agricultural Experiment Station, under authority conferred by Chapter 31, Public Acts of 1927, do hereby proclaim the towns of New Haven and West Haven subject to the restrictive regulations of this quarantine.

Also, the movement of all quarantined articles designated in the regulations

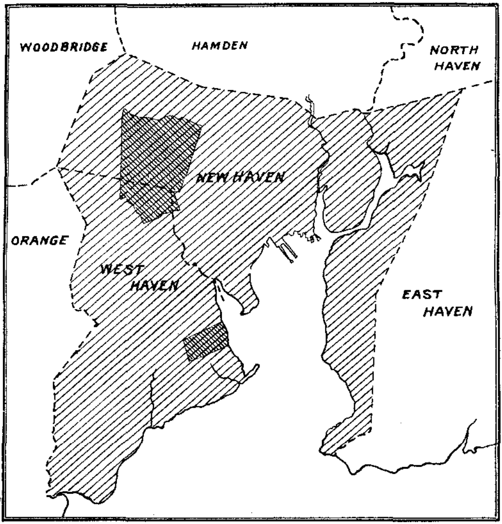


FIGURE 55. Map of New Haven and West Haven now under quarantine on account of Asiatic beetle. Darker shaded sections show infested areas, upon which additional restrictions have been placed by State quarantine.

supplemental hereto are further restricted from any point within the hereinafter designated control areas to other portions of the towns of New Haven and West Haven or to points outside thereof.

The following control areas are hereby designated:

Westville Area:—Bounded by Whalley Avenue, Blake Street, Ruby Street, Moreland Road, Ellsworth Avenue, Derby Avenue, Boulevard, Oak Street, Forest Road, Florence Avenue from a point about 400 feet west of Forest Road, in a straight line northward to West Prospect Street to Whalley

Avenue, and all territory within these boundaries, being partly in New Haven and partly in West Haven.

West Haven Area:—Bounded by Center Street, New Haven Harbor, Brown Street, and Campbell Avenue.

Until further notice the movement of certain articles and materials as designated below will *not* be permitted except where inspection or treatment is practicable and permits are issued by duly authorized agents of the State or the United States Department of Agriculture.

The articles and materials restricted during the entire year are as follows:

1. Sand, soil, earth, peat, compost and manure;
2. Nursery, ornamental and greenhouse stock, and all other plants;
3. Turf or sod trimmings, lawn or shrub clippings, ground litter, and weeds.

The articles and materials restricted only between June 15 and October 15, *inclusive, are as follows:*

1. Cut flowers.
2. Hay and straw (freshly cut).

The rules and regulations supplemental to Federal Quarantine No. 66, *effective on and after March 15, 1922, or any subsequent amendments thereto*, restricting the interstate movement of quarantined articles from the regulated areas, are hereby declared to be in full force and effect with respect to the intrastate movement of quarantined articles from the herein designated areas of Connecticut to portions thereof.

This order shall be effective on and after April 1, 1929.

W. L. SLATE,
Director, Connecticut Agricultural Experiment Station.

Approved:
JOHN H. TRUMBULL, *Governor.*

It should be noted that the state quarantine, like the Federal quarantine, covers the entire towns of New Haven and West Haven, but the state quarantine places additional restrictions upon the particular areas in those towns that are known to be infested. These areas are shown approximately in Figure 55 and specifically in Figures 56 and 57.

On May 17, 1929, the Asiatic beetle was discovered in a small lawn at 57 Ford Place, Bridgeport. Later, infestations were discovered at 685 Orange Street, and at 45 Glen Road, in New Haven, and at the corner of Main Street and Second Avenue in West Haven, all three being outside the special areas formerly known to be infested, though within the towns of New Haven and West Haven, both of which are under state and Federal quarantine. The Bridgeport infestation is, of course, wholly outside any area quarantined on account of this insect.

During November and December, Mr. B. W. McFarland visited 50 towns and cities in the central and western portion of the state, outside of the area quarantined on account of the Japanese beetle, to ascertain whether any lawns in public parks, golf courses, or on private estates, had been injured during the season

by white grubs. Mr. McFarland made inquiries of town officers, park superintendents, managers of large estates, and superintendents of golf courses. He also drove through the principal streets of these towns and cities and observed the condition of the lawns. Where any such injury had been reported or observed, he visited the localities and examined the soil for grubs. In a few places,

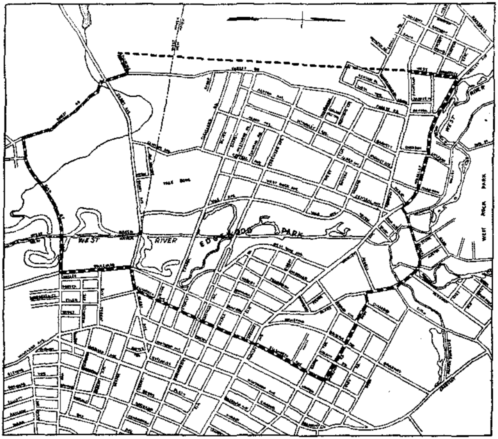


FIGURE 56. Map of the Westville section of New Haven. The area enclosed by dotted line is infested and under special State quarantine restrictions.

the grubs of May or June beetles, *Phyllophaga* sp., were found, but no evidence was secured of the presence of the Asiatic beetle.

The cities and villages visited by Mr. McFarland in this work are as follows:

Bantam
Berlin
Bethel
Bethlehem
Bridgewater
Brookfield
Brookfield Center
Cheshire
Cromwell
East Berlin
East Morris
Gaylordsville
Georgetown
Hawleyville
Hotchkissville
Kensington
Kent
Litchfield
Marble Dale
Meriden
Middlebury
Middletown
Milldale
Morris
New Britain
Newington
New Milford

New Preston	Ridgefield	Wallingford
Newtown	Rocky Hill	Washington
Northville	Roxbury	Watertown
North Woodbury	Sandy Hook	Wethersfield
Oakville	Sherman	Woodbury
Oxford	South Britain	Woodville
Redding	Southbury	Yalesville
Redding Ridge	Southford	

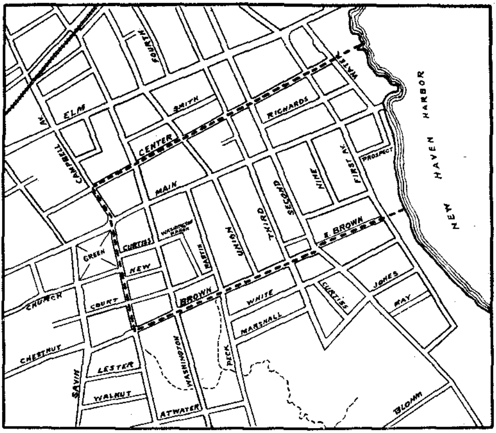


FIGURE 57. Map of section of West Haven. The area enclosed by dotted line is infested and under special State quarantine restrictions.

Mr. McFarland made 34 examinations on request, as follows:

Town	Number of examinations	Asiatic beetles found
New Haven	26	15
West Haven	6	2
Hamden	1	0
Milford	1	0
Total	34	17

Nearly all of these 17 places where Asiatic beetles were found were within the infested area. The first adult was found on June 22, and the last one on August 23. It is our plan to treat all of the outlying infestations with lead arsenate in order to kill the greatest possible number of beetles at the earliest possible date.

THE REVISED INSECT PEST LAW

At the 1927 session of the General Assembly, the insect pest law was revised in order to clarify its provisions and to give increased authority. In making the revision, the penalty clause was somehow omitted. Consequently, the law was again revised by the General Assembly of 1929. Slight changes were made in Section 1, and the penalty provisions were restored as Section 6. *The entire act as it now stands is as follows:*

CHAPTER 31, PUBLIC ACTS OF 1927

As Amended By

CHAPTER 45, PUBLIC ACTS OF 1929

AN ACT CONCERNING THE CONTROL OF PLANT PESTS

SECTION 1. The director of the Connecticut Agricultural Experiment Station shall have charge of all matters pertaining to official control, suppression or extermination of insects or diseases which are, or threaten to become, serious pests of plants of economic importance. He shall receive no additional compensation for such work, and may designate members of the station staff to carry out certain lines thereof and may employ such other assistance as may be required. Said director may coöperate with the agents of the United States department of agriculture in the control of plant pests; may make rules and orders, subject to the approval of the governor, regarding the destruction or treatment of infested plants; may seize, treat, disinfect or destroy any plants or plant material moved in violation of any quarantine, rule or regulation established under the provisions of said chapter 31 or of this act, or suspected of being infested by any dangerous insect pest or plant disease; may prohibit or regulate the transportation of plants and plant materials, brick, stone and quarry products or any other objects or materials liable to carry dangerous pests and may designate certain areas or districts wherein all such plants may be destroyed.

SEC. 2. Said director is authorized to promulgate, and to enforce by appropriate rules and regulations, a quarantine prohibiting or restricting the transportation of any class of nursery stock, plant, fruit, seed or other article capable of carrying any dangerous plant disease or insect infestation with reference to which the secretary of agriculture of the United States has not determined that a quarantine is necessary and established such quarantine, into or through this state or any portion thereof from any other state, the District of Columbia or any part of such state or said district in which said director shall have found such plant disease or insect infestation to exist.

SEC. 3. Said director is authorized to make rules and regulations for the seizure, inspection, disinfection, destruction, or other disposition of any nursery stock, plant, fruit, seed or other article capable of carrying any dangerous plant disease or insect infestation, a quarantine with respect to which shall have been established by the secretary of agriculture of the United States, and which have been transported to, into or through this state in violation of such quarantine.

SEC. 4. Said director may establish and maintain a quarantine against any premises, district, town or group of towns in this state, provided, before any quarantine shall be established within the state, a public hearing shall be held, of which a five days' notice shall be given to the parties affected, either by mail or by publishing such notice in two newspapers having a circulation in the part of the state affected by such quarantine. Said director, or any person authorized by him to enforce the provisions of this act, may, at any

reasonable time, enter any public or private premises in the performance of his duty.

SEC. 5. Any person aggrieved by any order of quarantine issued under the provisions of this act may appeal to the superior court, or to any judge thereof if said court shall not be in session, and said court or such judge may grant such relief or issue such order or judgment in the premises as to equity may appertain.

SEC. 6. Any person interfering with any person in the performance of his duty under the provisions of said chapter 31 or of this act or violating any quarantine or any other rule or regulation established under said provisions shall be fined not less than five dollars nor more than one hundred dollars.

SEC. 7. This act shall take effect from its passage.

Approved April 10, 1929.

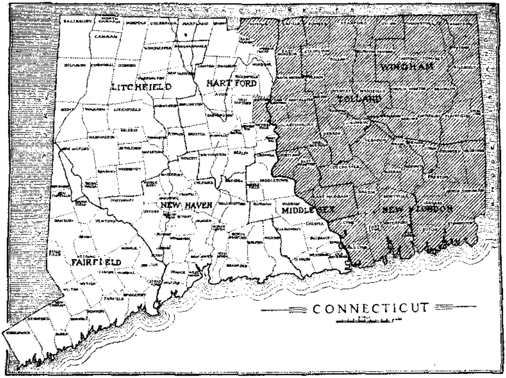


FIGURE 58. Map of Connecticut. Shaded portion is now under State and Federal quarantine on account of the satin moth.

SPREAD OF THE SATIN MOTH

In the report of this Station for 1926, page 264, is a brief account of the satin moth, *Stilpnotia salicis* Linn., and its occurrence in Connecticut. At that time it had been discovered in the towns of Stonington and Thompson, which had been placed under Federal quarantine. Illustrations showing the caterpillars and winter cases of the satin moth may be found on Plate XXI.

This insect feeds chiefly upon willows, but also attacks poplars, sometimes defoliating them. The caterpillars are often seen feeding with gipsy caterpillars and the writer observed such conditions in southeastern New Hampshire last June.

During the winter of 1928-29, state men examined trees in different parts of the state while scouting for gipsy moth eggs, and found the pest to be well scattered over the eastern portion of Connecticut. Also the towns of Hartford and Suffield, west of the Connecticut River, were found infested. Federal Quarantine No. 53 was therefore revised to include these two towns and all territory east of the Connecticut River, effective January 1, 1929. A public hearing regarding a state quarantine was held at the Station February 25, 1929, and the following quarantine order issued:

State of Connecticut

Agricultural Experiment Station

New Haven, Conn.

Quarantine Order No. 19

CONCERNING THE SATIN MOTH

The fact has been determined that the satin moth, *Stilpnotia salicis* Linn., a pest of poplar and willow trees, is now present in various towns in Connecticut, and that Federal Quarantine No. 53 has been revised, effective, January 1, 1929, to include all towns in Connecticut east of the Connecticut River, and the towns of Hartford and Suffield, west of the Connecticut River. After due notice a public hearing was held at the Station in New Haven, February 25, 1929.

Now, therefore, I, Director of the Connecticut Agricultural Experiment Station under authority conferred by Chapter 31, Public Acts of 1927, do hereby proclaim that a State quarantine is placed on all towns east of the Connecticut River, and the towns of Hartford and Suffield west of the Connecticut River, and that it shall be unlawful to move any poplar or willow trees or parts thereof capable of propagation, from the restricted area designated above to any other portion of the State.

This order shall take effect March 15, 1929.

W. L. Slate,
Director, Connecticut Agricultural Experiment Station.

Approved:
John H. Trumbull, *Governor.*

The quarantined area is shown in Figure 58. Late in 1929, state scouts reported that the satin moth had been observed in the following additional five towns: Burlington, Farmington, New Britain, Newington and West Hartford. These towns have not yet been placed under quarantine. The satin moth quarantine really amounts to an embargo and shipments of willow and poplar out of the quarantined area are prohibited, it being almost impossible to detect the winter cases. Consequently inspection and certification are not attempted.

THE ASIATIC GARDEN BEETLE IN CONNECTICUT

***Aserica castanea* Arrow**

In the summer of 1928, Mr. Harold C. Hallock of the Federal Bureau of Entomology, stationed at Westbury, Long Island, N. Y., visited New Haven and while walking with Dr. R. B. Friend across the Yale College campus, picked up a dead beetle, which he identified as *Aserica castanea* Arrow. Of course the origin of this beetle was unknown.

A Federal quarantine was established, effective March 15, 1929, covering certain portions of New York, Pennsylvania, and Virginia, and the entire State of New Jersey. Connecticut was not affected by this quarantine because no infestation of living insects of this species had then been discovered in Connecticut. Mr. McFarland was detailed to scout for this beetle evenings around lights on the Yale campus and on August 6, he collected two adults. Another found in New Haven, July 17, was sent in. Mr. Johnson's men carried on similar scouting for beetles in Bridgeport, Bristol, Canaan, Cromwell, Fairfield, Hartford, Middletown, Meriden, New Britain, North Manchester, Putnam, Stafford Springs, Stamford, Torrington, Wallingford, Willimantic, and Winsted and found no beetles. One adult was found in a Japanese beetle trap in New London.

During 1929, Japanese beetle scouts made diggings for grubs in various nurseries, and *Aserica castanea* grubs were found in the following towns: Cromwell, 25; Manchester, 10; Mansfield, 1; New Canaan, 2; and Southport, 2.

Both adults and grubs were identified by Mr. R. J. Sim, of the Japanese Beetle Laboratory at Moorestown, New Jersey. Hence, it is certain that this insect now occurs within the state.

In superficial appearance, this beetle resembles the other species of the genus *Serica,* from which it was separated. *Serica sericea* Ill. and *S. parallela* Casey perhaps most closely resemble *Aserica castanea* Arrow, which when discovered injuring lawns on Long Island was first identified as *Serica parallela.* See Plate XXVI, b.

The beetle is about three-eighths of an inch long, cinnamon brown, dull, the wing-covers well-marked with shallow grooves or striae. The beetles fly at night and are attracted to electric lights; they also feed at night and hide in the soil around the bases of the plants or under rubbish, where they pass the daytime.

The grubs live in the soil and feed upon grass roots, much like the grubs of the Japanese beetle and the Asiatic beetle. The beetles feed upon many kinds of plants, including aster, barberry, bean, cherry, chrysanthemum, currant, dahlia, geranium, catalpa and coniferous seedlings.

Control measures are: Spray with lead arsenate, three pounds in 50 gallons water, plus two pounds of flour, to kill the beetles;

lawns should be treated with lead arsenate, using about three pounds per 100 square feet mixed in the upper three inches of soil, to prevent injury from the grubs.

MOSQUITO CONTROL IN CONNECTICUT IN 1929

R. C. Botsford

The General Assembly, at its last meeting, increased the budget for mosquito control from $7,500 per year to $12,500 per year. This became necessary on account of the addition of about 3,000 acres of ditched salt marsh acceptable for maintenance by this Station. Our estimate showed that $15,000 per year was necessary to maintain properly all acceptable areas, but our request for this amount was not granted. It was therefore impossible to clean up all areas this season.

The new appropriation became available on July 1, and at this time a new plan of maintenance was put into practice. This plan was described in Bulletin 305 of this Station, which contained the report of mosquito control work for the season of 1928. The western district crew was supervised by Nicholas Matiuck; the central district by C. F. Johnson; and the eastern district by Albert Lindquist. Auto transportation was provided for each crew on a mileage basis. Areas under state maintenance were inspected by the Deputy in Charge, and all new ditching was laid out under his direct supervision.

All salt marsh areas that had been newly ditched or completely overhauled within the past five years were patrolled, and all necessary cleaning and spur ditching was done to prevent mosquito development. There remain some areas in Branford, Guilford, and Madison where reditching is necessary. This is being done as rapidly as funds will allow.

Twenty-seven towns in Connecticut contain salt marsh areas; 10 are completely ditched, nine partly ditched, and in eight no ditching has been done.

Work done under contract by Mr. John F. Ross consisted of ditching on Great Island, Old Lyme, in the spring. This utilized a $5,000 appropriation made by the town in 1928.

The town of Old Lyme appropriated another $5,000 in 1929. Work stopped December 24 after cutting 68,366 feet, making the total footage in Old Lyme 214,581 feet. The town of Hamden appropriated $2,500 and 68,357 feet of ditches were cut before freezing weather stopped the work. The large salt marsh at East River in Madison, which has been in bad condition for some time, was completely recut on contract, 148,506 feet of 10 x 24 ditches being remade.

In reviewing the activities of the past five years, we find 11 towns have expended a total of $50,000, representing a total of

2,000,000 feet of new ditching. In the towns of Stamford, East Haven, Branford, and Norwalk, the work was an expansion of ditched area. Westport, Hamden, Westbrook, Saybrook, Old Lyme and East Lyme were new in mosquito elimination work.

For data concerning all towns, the reader is referred to the following tabulation:

Status of Connecticut Salt Marsh Areas, 1929

Town	Salt marsh areas	Salt marsh ditched	Maintained by State	Total cost of ditching	Labor, cost maintenance, 1929	Labor, cost to complete ditching
Greenwich	200	200	none	$22,000.00	......	......
Stamford	300	300	300	3,245.80	$231.20	......
Darien	300	300	none	3,800.00	......	......
Norwalk	600	600	600	7,500.00	427.86	......
Westport	400	400	400	5,913.82	340.30	......
Fairfield	1,200	1,200	1,200	8,400.00	842.46	......
Bridgeport	173	....	....	......	......	$ 3,000.00
Stratford	1,315	....	....	......	......	20,000.00
Milford	630	....	....	......	......	9,500.00
West Haven	463	222	222	......*	891.46	3,500.00
New Haven	*750*	*750*	*675*	12,000.00	*264.53*	750.00
Hamden	571	250	250	4,210.17	......	1,000.00
North Haven	310	....	....	......	......	3,100.00
East Haven	545	300	300	3,747.52	119.92	1,300.00
Branford	895	895	895		304.21	......
Guilford	1,085	1,085	1,085	20,000.00	1,208.78	......
Madison	1,315	1,315	1,315		5,233.97	......
Clinton	785	677	500	10,000.00	215.60	2,000.00
Westbrook	500	500	500	7,428.14	136.30	......
Old Saybrook	1,373	186	186	2,000.00	448.00	13,000.00
Lyme	493	....	....	......	......	7,500.00
Old Lyme	1,393	300	300	5,364.52	296.25	7,700.00
East Lyme	424	130	130	1,480.60	176.60	4,000.00
Waterford	204	....	....	......	......	3,500.00
New London	34	....	....	......	......	500.00
Groton	304	50	50	1,000.00	10.35	4,000.00
Stonington	555	....	....	......	......	8,500.00
Totals	17,117	9,660	8,908	$118,098.57	$11,147.79	$92,850.00

Mosquito Control in New Canaan

In New Canaan, an inland town, effective anti-mosquito operations were carried out this year. This movement started on September 27, 1922, when a Red Cross Mosquito Committee was formed, composed of Prof. W. H. Burr, and Messrs. W. E. Swift, G. A. Suter and W. T. Cox, secretary. A preliminary report on mosquito breeding conditions around New Canaan was made by Mr. Walden of this Station in May, 1923, at the request of this committee. From time to time inspections were made and reports submitted concerning mosquito breeding conditions within a radius of one and one-half miles of New Canaan center.

* Ditched with New Haven.

In 1927, a local committee, composed of Messrs. Merrill F. Clarke, Wilmot T. Cox, George A. Suter and Archibald E. Stevenson requested and received an appropriation of $1,000 from the town of New Canaan and the best of coöperation from the town officers, especially Mr. George T. Smith, First Selectman.

This fund was used for oiling the worst breeding places within the central area. The results were so gratifying that a larger sum was appropriated late in 1928, to be expended the following season. In 1929, the committee requested the Station to appoint an expert on mosquito control, who would also be a special deputy with some authority, to supervise the treatment work, study all local mosquito breeding conditions, collect and identify mosquitoes, and submit a complete report. In other words, the committee wished to set an example which might be followed with profit by other towns having similar problems. New Canaan was to be considered an outdoor laboratory for the study of the local mosquito problem and this deputy was expected to inaugurate tests and trials, and make recommendations looking toward its solution. To this special position the Station appointed Mr. Raymond F. Hart, who had served for two summers as a mosquito inspector of the Health Department of the City of New Haven. The report of Mr. Hart follows.

To Dr. W. E. Britton, State and Station Entomologist of the Connecticut Agricultural Station; and to Mr. George T. Smith, First Selectman of the Town of New Canaan.

GENTLEMEN:

I submit, herewith, my report of the season's work in mosquito control in New Canaan, conducted under the supervision of the Connecticut Agricultural Experiment Station. This work covered a period from April 13 to September 14.

The number of mosquito breeding places found totals 70. The most important place, because of the heavy breeding there, was the filter beds. Mosquito larvae in extraordinary numbers were found there several times during the summer, and each time the beds were oiled before the larvae could hatch into mosquitoes. In May, a few pupae were found in two of the beds; but these beds were dry in a few days. In June, another bed was found breeding slightly, and this was treated. Then in July, there was heavy breeding in all the beds on two occasions, necessitating oiling. Once again in August and once in September, there was heavy breeding in all the beds, and they were oiled. Once in the latter part of July and again in the early part of August, there was slight breeding in one bed, and oil was applied. In two concrete holes near the chlorination house, heavy breeding was discovered once in June and twice in July, and these were treated similarly. A water

pipe near the beds was also oiled in July. The proper way of preventing mosquitoes from breeding in the filter beds would be to run them on a definite schedule, so that each bed would be systematically drained every eight or ten days. Allowing three or four days for each bed to dry out, the bed would have water in it for only five or six days, and this period would not be of sufficient duration to allow the mosquitoes to hatch, the time necessary for a mosquito to pass from the egg to the adult stage being from seven to ten days. Since the limited capacity of the filter beds did not permit this procedure, oiling became necessary.

The place next in importance in breeding was along the edges of the Five Mile River, below the point where it receives the effluent from the filter beds. Very heavy breeding was found in the middle of June, and breeding to a lesser extent in July, August, and September, once each month; each time the edges of the river were oiled.

A description of the 68 remaining breeding places is as follows:

Thirty were ponds and pools, of which 19 were oiled, two were treated with a larvacide, and nine did not require oiling, because they had but few larvae and were in isolated localities; 14 were swamps and marshes, of which eight were oiled, and six did not require oiling; 10 were streams and brooks, of which seven were oiled, two dried up, and one was in an isolated spot; three were the hoofprints made by cattle, and were oiled; two were catch basins in the roadside and were oiled; two were ditches in the road, which were oiled, and later were found dry; one was a hole among the rocks on the edge of a pond; this was oiled; one was an isolated hole in the woods with only a few larvae; one consisted of two wooden tanks, one in the stables of a barn, the other in the ground behind the barn; they were both oiled; one was a tub for catching the overflow water from a well; the water was emptied from the tub; one was a hole in the ground next to a tennis court; this dried up; one was a well with one or two larvae dipped up in the bucket; one consisted of the notches in a wooden beam of a broken-down mill.

Of the 70 breeding places, 26 were Anopheles—malarial—breeding places, evenly distributed about the town. Of these 26 there was heavy breeding in only eight. These eight places were as follows:

The bird sanctuary duck pond. Several Anopheles larvae were found in May, but the hole dried up; heavy Anopheles breeding was found in July, and the pond was oiled; the pond dried up the latter part of July, and remained dry until September.

Swampy land off Ponus Ridge. Several Anopheles larvae were found in hoofprints in June; these were oiled, and drainage ditches dug. In August many Anopheles larvae were found in the stream running through; this also was oiled.

Dickerman pond off River Street. Several Anopheles larvae were found on three occasions in June, July, and August—once each month—and the edges of the pond were oiled.

The smaller Rae pond on Stamford Road. Anopheles larvae were found in July on two occasions, and the edges of the pond oiled; in the latter part of August, the pond dried up, and remained dry until September.

Pinkham pond on Ponus Ridge. Anopheles larvae were found in July and August, and the edges of the pond were dusted with a mosquito larvacide.

A small pool on Jelliff Mill Road, opposite Jelliff's Mill. Many Anopheles larvae were found the last week in July, and the pool was oiled; thereafter, there was no breeding.

A ditch on the Renner property off Marvin Ridge Road. Many Anopheles larvae were found early in August, and the ditch was oiled; thereafter, there was no breeding.

The smaller pond on the Lapham place. Anopheles larvae were found during the middle of August, and the pond was oiled; afterwards it dried up.

Of the remaining 18:

Nine were ponds, of which five were oiled, and four did not require oiling.

Seven were streams, of which five were oiled, one dried up, and one did not require oiling.

Two were small swampy areas, of which one was oiled, and the other did not require oiling.

All but a few of the back yards within a one-mile radius were inspected for breeding. There were 36 back yard breeding places found, 31 of which were within a one-mile radius. All of the breeding places found were eliminated. There are approximately 31 blocks within the one-mile radius, making an average of one breeding place per block. On one side of Summer Street in the same block, there were five different yards with receptacles breeding mosquitoes; on one side of Harrison Street, there were four such yards.

Night catches for the purpose of catching and identifying mosquitoes were made at 17 different places. These night catches were of 15 minutes duration. At eight places, no mosquitoes were caught; at eight, one mosquito was caught; and at the other, eight mosquitoes were caught. Of the 18 mosquitoes caught, seven were *Anopheles punctipennis,* one was *Anopheles quadrimaculatus,* five were *Mansonia perturbans,* the irritating mosquito, one was *Aedes sylvestris,* the swamp mosquito, one was *Culex pipiens,* the house mosquito, and three were imperfect specimens, which could not be identified. *Anopheles punctipennis* were caught at five out of nine places.

Of 30 mosquitoes caught in the day time, 13 were *Culex pipiens,* six were *Orthopodomyia signifer,* the white-lined mosquito, four were *Aedes canadensis,* the woodland pool mosquito, four were *Aedes triseriatus,* the tree-hole mosquito, one was *Aedes sylvestris,* and two were imperfect specimens, which could not be identified.

Of 96 mosquitoes hatched, 57 were *Culex pipiens,* 21 were *Anopheles punctipennis,* 17 *Aedes canadensis,* and one *Aedes sylvestris.*

The results show *Culex pipiens* as the predominating mosquito, with *Anopheles punctipennis* second, and *Aedes canadensis* a close third. *Orthopodomyia signifer* is a fairly rare species in Connecticut; *Aedes triseriatus* is also rare.

Most of the *Anopheles* mosquitoes found were *punctipennis.* One *quadrimaculatus* was taken in a night catch. *Anopheles punctipennis* was the most abundant mosquito in the town next to *Culex pipiens,* as might be expected from the high number of Anopheles breeding places, 26 out of a total of 70.

Towards the latter part of the season, experiments were made with *Fundulus heteroclitus,* the common killifish, which is effective in salt-marsh mosquito control work, to see if it could be used in an inland town. Many of these fish were put into 11 ponds about the town.

Experiments were also made with *Rhinichthys astronasus,* the black-nosed dace, a fish prevalent in New Canaan waters. The purpose was to ascertain whether it would eat mosquito larvae. Larvae put into a barrel with the dace disappeared by the next day. The same results followed with larvae put into a jar with dace. Larvae also disappeared from a barrel that was breeding mosquitoes, after 25 or 30 fresh dace had been put in.

Larvae were also put into a pond with dace, and five days later Anopheles larvae were found in addition, an Anopheles mosquito having laid her eggs in the interval. Leaves found around the edges of the pond, which might shelter the larvae from the fish, rendered this experiment inconclusive.

On the whole, this season's experiments have not disclosed sufficient facts to draw definite conclusions about the usefulness of these fish in the work.

In closing, I wish to express my thanks to the members of the Experiment Station Staff, to the selectmen and other town officials, and to the members of the voluntary committee for their kindly aid and helpful suggestions; and to the people of New Canaan for their splendid spirit and willing coöperation.

Respectfully submitted,

RAYMOND F. HART,
Special State Deputy in Charge.

September 14, 1929

MISCELLANEOUS INSECT NOTES

European Pine Shoot Moth in Hamden: On May 21, Mr. Zappe collected some larvae of the European pine shoot moth, *Rhyacionia buoliana* Schiff., in shoots of the red pine near Lake Whitney. Adult moths emerged on June 14. See Plate XXV.
[W. E. Britton]

Leaf Rollers on Rose: On May 27, some leaf rollers were collected from rose in the writer's garden and placed in breeding cages in the Station insectary. Adults emerged on June 12-15, and three species of moths were obtained. These were *Archips rosana* Linn., *Tortrix albicomana* Clem., and *Epiblema suffusana* Zell. See Plate XX. [W. E. Britton]

Strawberry Whitefly: During September, Doctor Garman brought to the office some strawberry leaves from a field in Branford where on several acres considerable injury had been caused by a whitefly. An examination of the leaves showed it to be the strawberry whitefly, *Trialeurodes packardi* (Morrill). The nymphs were all over the under sides of the leaves. It is a question what remedial measures in a large field will prove effective. The leaves are so close to the ground that spraying is impracticable. Possibly a strong nicotine dust or a cyanide dust could be used, but we have not given either a trial. [W. E. Britton]

Lyctus Beetles: On May 21, the writer had occasion to examine an ice-box in a private residence in New Haven from which adults of *Lyctus opaculus* LeConte were emerging in considerable numbers. This occurrence of these beetles was remarkable in that the ice-box had been in the possession of the family for eight years and no insects had been previously noticed. The wood, ash, was well varnished and there were no exit holes other than those being made at the time of the examination. The probability of the infestation having occurred since the ice-box was made is extremely remote. The adults oviposit in pores in wood, and a coat of varnish acts as a deterrent. [R. B. Friend]

Injury to Young Coniferous Trees by White Grubs: During the season of 1929, the young conifers in the nursery of the State Forester at Simsbury were severely injured by white grubs, *Phyllophaga* sp. The beds of Norway spruce were particularly affected, one-fourth to one-third of the trees in one bed being killed. These trees were two years old and had been transplanted once. When the nursery was examined November 5, the brown areas of dead plants were quite conspicuous. The grubs had eaten off all the small roots and the tips of the larger roots from these plants that were killed. At the time the examination was made, no grubs were present around the roots of the plants, but were found at a depth of about two feet in the soil.
[R. B. Friend]

Kermes on Black Oak: In response to a request from the park department of the City of New Haven, several black oaks in East Rock Park were examined on August 12. Small branches on several of these trees were injured by a species of *Kermes*, possibly *Kermes galliformis* Riley. The females occurred in groups around the branches, see Plate XXIII, b, killing the plant tissue and causing it to become darkly colored and shrunken. This scale bears a superficial resemblance to a gall and has been frequently mistaken for such. With two exceptions all the species of *Kermes* occur on oaks and are commonly known as oak gall scales. It is the female sex which causes the injury to the trees; little is known about the biology of the males. [R. B. Friend]

Aphids on Ferns: In February, 1929, attention was called to a heavy infestation of aphids on Boston ferns in the Station greenhouse. These aphids proved to be the black fern aphid, *Idiopterus nephrelepidis* Davis. They feed almost entirely on the under surface of the older fronds. The leaflets were not curled and infested plants showed no direct evidence of injury. The species is a native of the tropics, and in this case was found on ferns recently purchased from a local dealer. See Plate XIX, b.

Sprays of nicotine sulfate with soap and pyrethrum soap at the usual dilution easily controlled this aphid. In spraying, care must be taken to cover the under side of the fronds, where the aphids feed. This can be accomplished by turning the pots on the side, or by use of a spray rod, which directs the spray material against the under side of the fronds. [Neely Turner]

Rose Midge in Greenhouse: In the report of this Station for 1922, page 372, is a note concerning the rose midge, *Dasyneura rhodophaga* Coq., which had injured rose plants in greenhouses in Greenwich. On November 26, 1929, Dr. Friend and Mr. Zappe visited a large rose-growing establishment in Guilford, where considerable injury had been caused by this insect on certain varieties in certain sections of the house. The maggots work in the buds, particularly the flower buds and deform the developing flowers, and the result is often a distortion and blackening of the tender shoots. The maggots enter the soil and pupate and the tiny flies or midges emerge later. It is not a destructive pest of roses out-of-doors. One of the best control measures is to cover the surface of the soil with a layer of ground tobacco, one-fourth inch in depth and to fumigate the house each night for a time, by burning tobacco stems or with one of the commercial nicotine preparations. [W. E. Britton]

Stalk Borer Infesting a Corn Field: On June 19, a report was received from the New Haven County Farm Bureau, that a farmer in East Wallingford was having trouble with borers in his corn

that might prove to be European corn borers. Upon examining the field of about two acres, it was found that the insect was the common stalk borer, *Papaipema nitela* Guen.

The previous owner had a vineyard on this land, which had not been cultivated the past season. There were probably many large-stemmed weeds that had been infested with stalk borers. The present owner pulled out the grapevines in the fall and planted corn in the spring.

The corn was from four to six inches tall and the leaves were turning yellow with many of the tips curled and drying up as shown on Plate XXVII. A count of the plants in short sections of rows in different parts of the field showed from about 15 per cent to more than 50 per cent of the plants infested. The average infestation was estimated to be between 25 and 30 per cent. It was recommended that the owner pull out and burn the infested plants and replant the field. [B. H. Walden]

Injury to Golf Greens by Crambus Larvae: The grass on several of the golf greens of the Wampanoag Country Club at West Hartford was more or less severely injured by the larvae of a species of *Crambus* in the middle of the summer. When the greens were examined August 6, adults of *Crambus leachellus* Zincken were abundant, and it is assumed that this species was responsible for the damage. The injury consisted of small dead winding "lanes" each of which was caused by a single larva. The greens were in the process of being treated with lead arsenate as recommended for the control of the Japanese beetle, and those which had been treated showed little or no injury.

The injury by species of *Crambus* to sod land may be distinguished from that due to other insects by the presence of a web, which the larva spins as it works its way through the sod on or just below the surface. This injury usually passes unnoticed unless very severe. Fertilization of the land will minimize injury by promoting a vigorous growth of the grass, and the lead arsenate treatment as mentioned above should be effective. The biology and control measures of a closely related species, *Crambus trisectus* Walker, have been published by G. G. Ainslie in the United States Department of Agriculture Technical Bulletin 31, November, 1927.
[R. B. Friend]

Grass Injured by White Grubs: On September 11, Mr. Johnson investigated a case of white grub injury at Stafford Springs, Conn. In an area of nearly 100 acres, about half of which was residential, and the rest containing a baseball diamond, a portion estimated at 20 acres had the roots eaten off so that the grass was dead and brown. The turf could be rolled up like a carpet as shown on Plate XVI. Ten specimens of grubs brought to the Station were identified by Doctor Friend as larvae of June beetles.

Nine of them were *Phyllophaga fusca* Fröl., and the other was of the same genus though it is doubtful whether or not it is the same species. On September 19, Dr. Friend and Mr. Johnson visited two residences in the Buckingham section of Glastonbury. At one place white-grubs had killed the grass on the front lawn and at the other, grass in the backyard had been killed. These grubs were all June beetle larvae, *Phyllophaga* sp. *Phyllophaga* larvae were also received from Salisbury, August 16. In most infestations of this kind, the greatest injury is caused by the nearly mature grubs, which soon transform and emerge as beetles. Three years are required for the complete life cycle, and though some beetles appear and some eggs are laid each season, they may have periods of great abundance and destructiveness, three years apart. It is generally best to cultivate infested fields, and to plow and reseed grass fields and remake lawns where injury occurs.

[W. E. Britton]

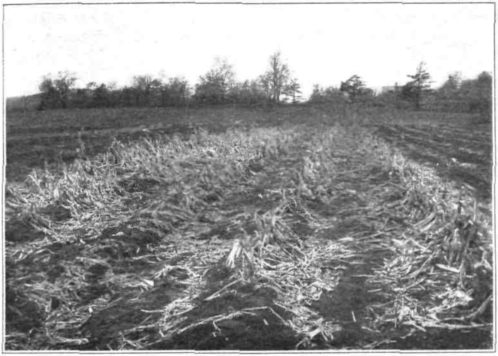
The Pit-making Oak Scale: The pit-making oak scale, *Asterolecanium variolosum* Ratz., is locally abundant on chestnut oak, *Quercus prinus,* in Connecticut and frequently injures young trees severely. This insect is indigenous to Europe, where it is found on the British Isles and the Continent, but from its native home it has spread to many parts of the world, being reported from South Africa, New Zealand, New South Wales, Argentina, United States and Canada. Except for its occurrence on olive, reported in California by Essig, it confines itself to oaks. In Connecticut, this scale has been found on scarlet oak, chestnut oak, white oak, and English oak. In the woodland areas near New Haven, it is a serious enemy of young chestnut oak reproduction, often killing small branches or even the entire plant. On white oak it occurs frequently, but not usually in injurious numbers. On the imported English oak, an ornamental tree, it may be a serious pest. See Plate XXIII, a.

Certain natural agencies exercise more or less control over this insect. In America and Europe it is parasitized by the encyrtid *Habrolepis dalmanni* Wwd., and an attempt has been made to establish this parasite in New Zealand. In England, according to Newstead (Monograph of the Coccidae of the British Isles, Vol. I, 1901), it is fed upon extensively by the blue titmouse, *Parus caerulens,* during the winter, and to some extent by the long-tailed titmouse, *Acredula caudata,* during the same season. Artificial control measures should be effective where they are practicable. A dormant spray of lime-sulfur or oil emulsion is recommended. [R. B. Friend]

INDEX

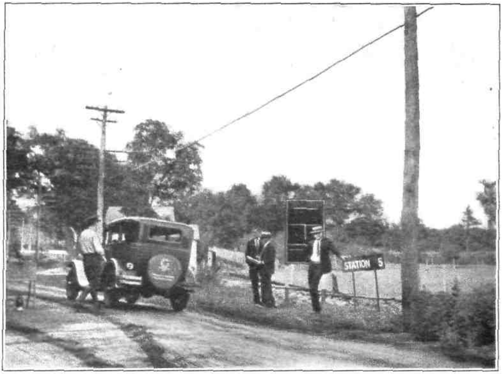
Acredula caudata, 617
Adelges abietis, 496, 502, 503, 505, 506.
pinicorticis, 496
Aedes canadensis, 613
sylvestris, 612, 613
triseriatus, 613
Agrilus, 503
anxius, 495,
Agromyza clara, 496
Alsophila pometaria, 492
American foul brood, 521
Anasa tristis, 495
Anisota rubicunda, 503
stigma, 503
Anomala orientalis, 486, 499, 590, 599
Anopheles punctipennis, 612, 613
quadrimaculatus, 612
Anthrenus scrophulariae, 499
Anuraphis roseus, 491
Aphis pomi, 491
Aporia crataegi, 518
Aquatic flies, 587
Aramigus fulleri, 585
Archips cerasivorana, 500
rosana, 497, 614
Argyresthia thuiella, 495
Aserica castanea, 500, 590, 592, 597, 599, 607
Asiatic beetle quarantine, 599
Asiatic garden beetle, 607
Aspidiotus perniciosus, 491
Asterolecanium variolosum, 497, 617
Aulacaspis pentagona, 498
rosae, 492
Autographa brassicae, 494
Bacillus larvae, 521
pluton, 520
Bees, registration of, 527
Benacus griseus, 500
Blissus leucopterus, 499
Brachyrhinus ovatus, 498, 504
sulcatus, 498, 504, 585
Calophasia lunula, 518
Carpocapsa pomonella, 493
Catalpa bungei, 496, 498
Celastrus, 503
Ceratomegilla fuscilabris, 584
Chaoborus punctipennis, 588
trivittatus, 588
Chionaspis euonymi, 498
pinifoliae, 496, 578
Chrysochus auratus, 500
Coleophora laricella, 495
Colopha ulmicola, 496
Conotrachelus nenuphar, 493
Contarinia pyrivora, 492
Convention of Entomological Workers, 500-502
Crambus leachellus, 616
Crataegus, 503, 504, 505
Crepidodera helxines, 503
Crioceris asparagi, 494
Cryptorhynchus, 503
Ctenocephalus canis, 499
Culex pipiens, 612, 613
Cytisus, 503
Dasyneura rhodophaga, 615
Dermestes vulpinus, 500
Diabrotica vittata, 494
Diarthronomyia hypogaea, 498
Dilachnus strobi, 496
Emphytus cinctus, 518
Entomosporium, 506
Epiblema suffusana, 614
Epicauta marginata, 494, 499
Epilachna borealis, 494, 583
corrupta, 493, 581, 583, 584
Epitrix cucumeris, 494, 499, 503
Eriococcus azaleae, 504
Eriophyes pyri, 493
Eriosoma lanigerum, 491
Eulia velutinana, 492
Euonymus, 503, 504
European corn borer, 563-568
European foul brood, 520
Euvanessa antiopa, 495
Exhibits, 487
Fenusa pumila, 486, 496, 504, 505
Field and lawn insects, 499
Fruit insects, 491
Fundulus heteroclitus, 613
Gillettea cooleyi, 496, 502, 503, 505, 506
Gipsy moth work in Connecticut, 529-543
cost of spraying woodland, 543-563
Gnomonia ulmi, 505
Gryllotalpa hexadactyla, 500
Habrolepis dalmanni, 617
Helicobia (Sarcophaga) helicis, 584
Heliophila unipuncta, 495
Heliothis obsoleta, 494, 567
Household insects, 499
Hylemyia brassicae, 495
Hyphantria cunea, 495
Icerya purchasi, 498
Idiopterus nephrelepidis, 615
Insects attacking flowers and greenhouse plants, 498
ornamental shrubs and vines, 497

Inspection of apiaries in 1929, 519-529
imported nursery stock, 516
nurseries, 502-516
Japanese beetle,
soil treatment, 589
scouting, 589
quarantines, 592
Kalmia latifolia, 515
Kermes galliformis, 497, 615
Laspeyresia molesta, 485, 493
Lecanium corni, 492
nigrofasciatum, 497
Lepidosaphes ulmi, 496
Leptinotarsa decemlineata, 494
Leucaspis japonica, 497
Lithocolletes hamadryadella, 495
Lonicera, 503
Lyctus opaculus, 500, 614
Lygaeonematus erichsoni, 496
Lygidea mendax, 491
Lygus pratensis, 498
Macronoctua onusta, 498
Malacosoma americana, 492
Mamestra picta, 494
Mansonia perturbans, 612
Marsonia juglandis, 505, 506
Melalopha inclusa, 504
Melanotus sp., 499
Melittia satyriniformis, 494
Mexican bean beetle, 493, 581-585
Miscellaneous insects, 500
Monarthropalpus buxi, 497
Mosquito control work, 608-613
Myzus cerasi, 491
ribis, 491
Neodiprion pinetum, 496
Nepticula sericopeza, 495
Notolophus antiqua, 518
Oil sprays
for killing European red mite eggs, 571-575
against aphids and European red mites, 576-578
Olethreutes hebesana, 498
Ormenis pruinosa, 504
Orthopodomyia signifer, 613
Oryzaephilus surinamensis, 500
Pantamorus godmani, 499, 585
Papaipema nitela, 494, 568, 616
Paradexodes epilachnae, 584
Paratetranychus pilosus, 493, 571
ununguis, 497
Parus caerulens, 617
Pegomyia hyoscyami, 495
Peridroma margaritosa, var. *saucia*, 498
Phorocera claripennis, 584
Phlyctaenia ferrugalis, 498
Phyllocoptes schlectendali, 497
Phyllophaga sp., 499, 602, 614, 617
fusca, 499, 617
gracilis, 499
Phytomyza aquilegiae, 498
Pine leaf scale, 578-581
Pinus sylvestris, 579
Pissodes strobi, 496
Pityogenes hopkinsi, 496
Plagiodera versicolora, 496, 504, 506
Plutella maculipennis, 494
Poecilocapsus lineatus, 498
Podisus maculiventris, 584
Pontia rapae, 494
Popillia japonica, 500, 590, 591, 592
Prociphilus imbricator, 496
Prunus pissardi, 503
Pseudococcus citri, 498
Psila rosae, 495
Psylla pyricola, 491
Pteronidea ribesi, 485
Ptinus fur, 500
Pulvinaria vitis, 497
Pyrausta nubilalis, 494, 564, 568
Quercus prinus, 617
Rhagoletis pomonella, 492
Rhinichthys astronasus, 613
Rhizoglyphus hyacinthus, 499
Rhyacionia buoliana, 495, 614
Ribes, 506, 515
nigrum, 516
Rosa manetti, 517
rugosa, 517
Sacbrood, 522
Saperda, 503
Serica, 607
parallela, 607
sericea, 607
Shade and forest tree insects, 495
Sphecodina abbotii, 497
Stilpnotia salicis, 605, 606
Stiretrus anchorago, 584
Tarsonemus pallidus, 499
Tests of various apple sprays, 569-571
Tetranychus bimaculatus, 499
Thermobia domestica, 500
Tmetocera ocellana, 492
Tolype velleda, 492
Tortrix albicomana, 614
Toumeyella liriodendri, 497
Trialeurodes packardi, 492, 614
Tsuga canadensis, 578
Vegetable insects, 493
Xylina antennata, 492
Zeuzera, 503
pyrina, 492

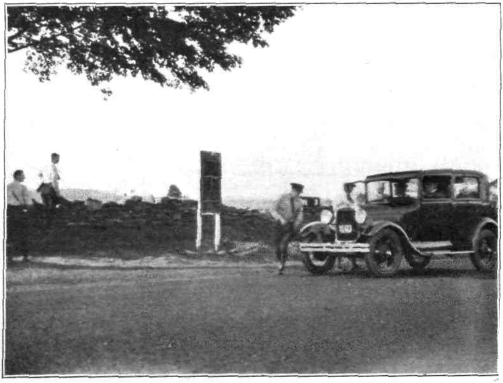


a. Sweet-corn patch in eastern Massachusetts heavily infested with borers. The stalks are so weakened by the feeding of the borers that they soon break over. (After Mass. Dept. of Agric.)

b. European corn borer road patrol station No. 12, Clinton-Madison town line, Post Road.



a. European corn borer road patrol station No. 5, Windham-Mansfield town line.

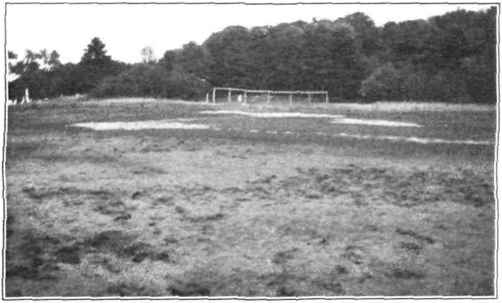


b. European corn borer road patrol station No. 3, Killingly-Brooklyn town line.

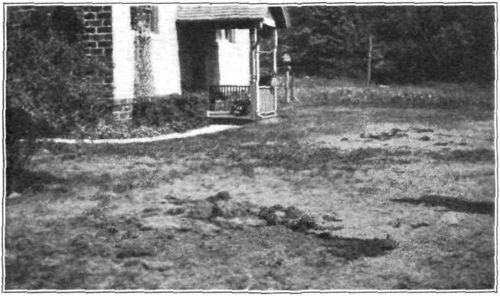
a. European corn borer plowing demonstration, Branford.

b. European corn borer plowing demonstration, Branford.

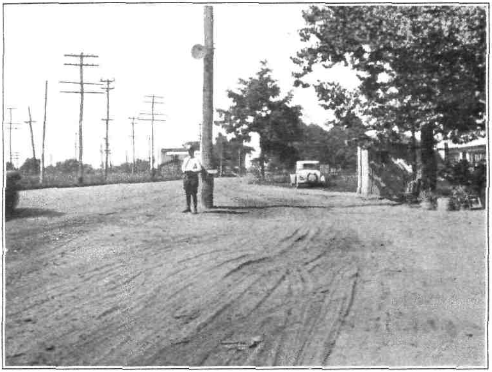
PLATE XVI



a. Lawn injured by white grubs, Stafford Springs.



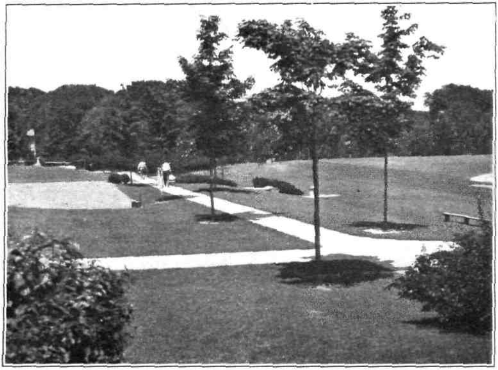
b. Lawn injured by white grubs, Stafford Springs.



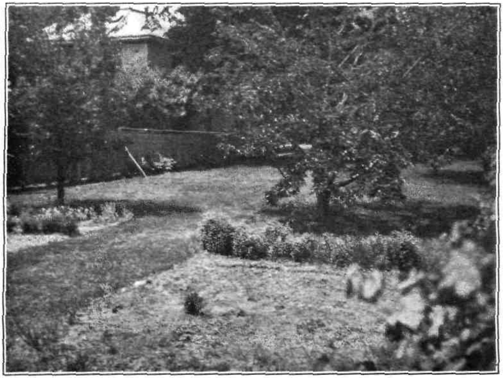
a. Japanese beetle road patrol station, Wallingford-North Haven town line.

b. Japanese beetle road patrol station, Wallingford-North Haven town line; uncertified nursery stock left at station.

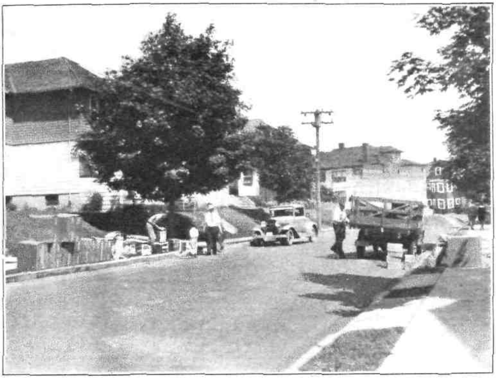
PLATE XVIII



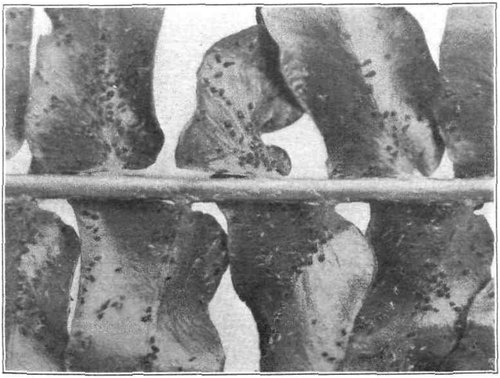
a. Japanese beetle treated area on grounds of Hartford Life Insurance Company, Hartford.



b. Japanese beetle treated area in adjoining yard, Hartford.



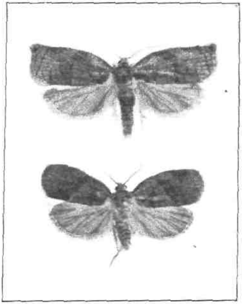
a. Unloading Japanese beetle traps, Hartford.



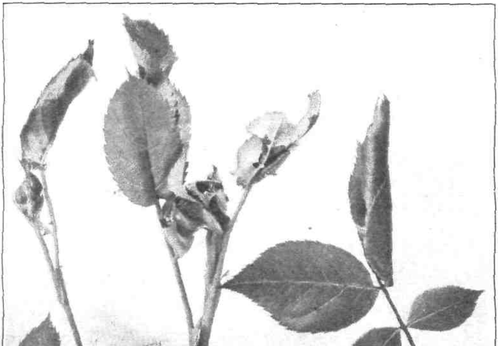
b. Aphids on fern in greenhouse, twice enlarged.

PLATE XX

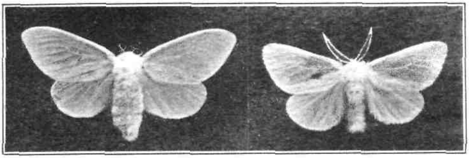
a. Leaf roller, *Archips rosana*, larvae and pupa, twice enlarged.



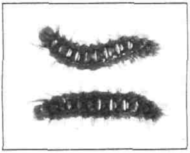
b. Leaf roller, *Archips rosana*, adult moths, twice enlarged.



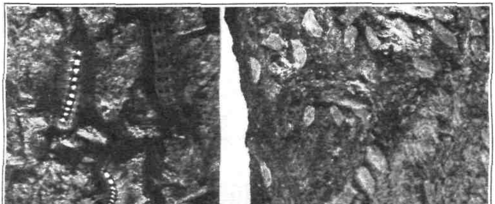
c. Leaf roller, *Archips rosana*, injury to rose; natural size.



a. Female and male satin moths, natural size. (After Burgess and Crossman, Dept. Bull. 1469, U. S. Dept. of Agric.)

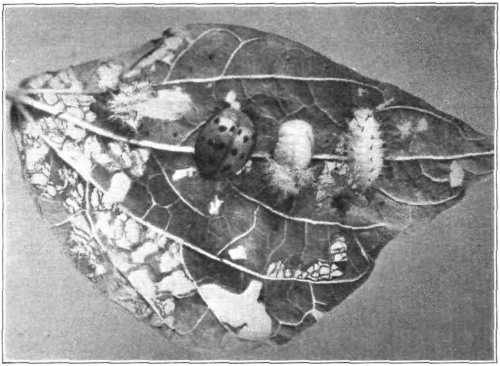


b. Satin moth larvae, natural size.

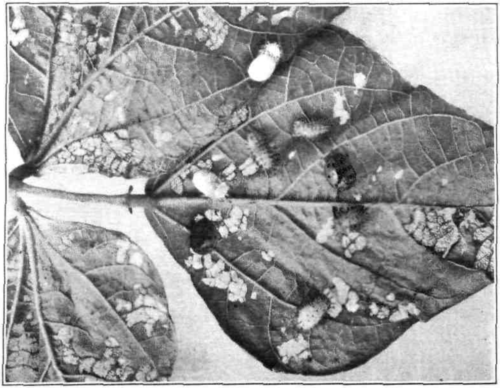


c. The satin moth. At left, caterpillars, and at right, winter cases. (After Burgess and Crossman, Dept. Bull. 1469, U. S. Dept. of Agric.)

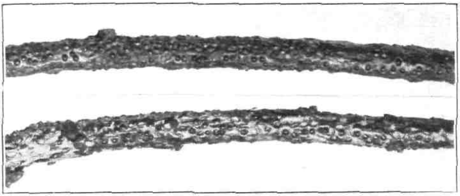
PLATE XXII



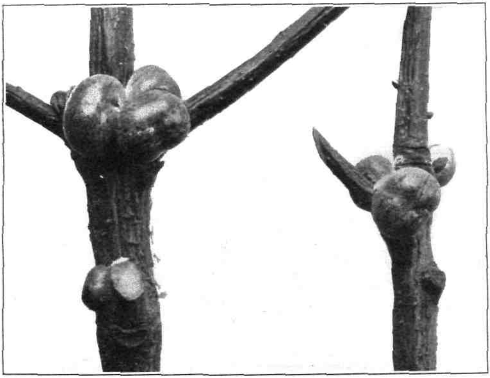
a. Mexican bean beetle, adult, pupa, larva, and injured leaf; twice enlarged.



b. Mexican bean beetle adults, pupa, larvae, and injured leaf; natural size.

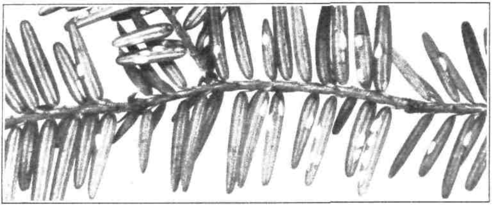


a. Pit-making oak scale, natural size.

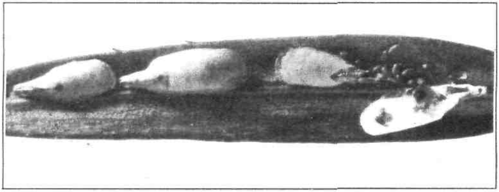


b. Oak gall scale on oak, twice enlarged.

PLATE XXIV

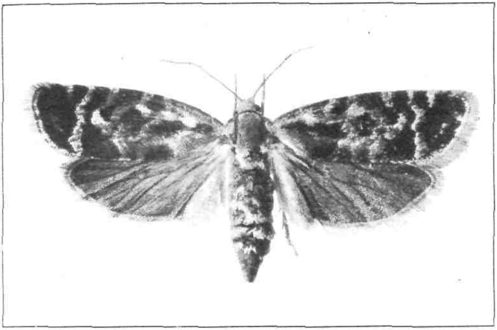


a. Pine leaf scale on hemlock, twice enlarged.

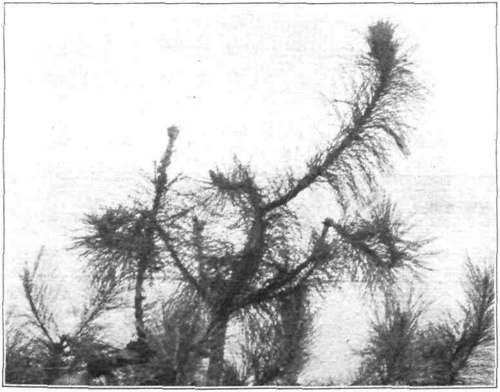


b. Pine leaf scale on hemlock, female shells showing eggs, ten times enlarged.

c. Pine leaf scale on pine, twice enlarged.

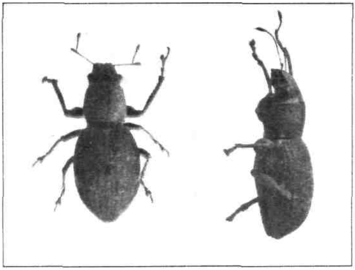


a. European pine shoot moth, adult, four times enlarged.

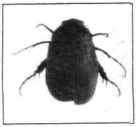


b. European pine shoot moth injury to red pine.

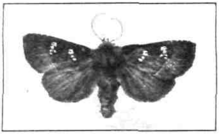
PLATE XXVI



a. Fuller's rose beetle, adults, four times enlarged.

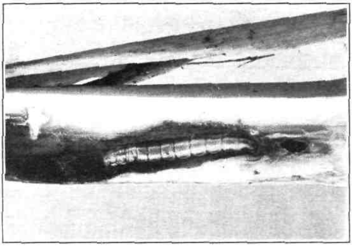


b. Asiatic garden beetle, twice enlarged.



c. Adult of stalk borer, natural size.

d. Immature stalk borer in corn, naturâl size.



a. Stalk borer larva in corn stalk, natural size.

b. Corn injured by stalk borer.

PLATE XXVIII

a. Mosquito breeding area at South End, East Haven, before ditching.

b. Same area after ditching and filling part of the foreground.

Bulletin 316 April, 1930

A MAPLE LEAF DISEASE CAUSED BY CRISTULARIELLA DEPRAEDANS

PAUL R. BOWEN

Connecticut
Agricultural Experiment Station
New Haven

The bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

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FOREWORD

In the last twenty years the writer has paid particular attention to the diseases of trees in Connecticut. These have been of various types. First there was the chestnut blight which, soon after its discovery here in 1907, developed very rapidly and killed all of the chestnut trees, though the seedlings and sprouts from the old stumps continue to exist. Then came the white pine blister rust which requires Ribes for its alternate host but which proves a far more serious enemy to the white pine, especially in its seedling stage needed for natural reproduction in the pine areas. Very recently we have had to deal with the willow scab, which suddenly developed under unusually moist spring conditions, particularly in the northwestern part of the state, and has already killed many of the large shade trees of *Salix alba* var. *vitellina,* its most susceptible host. These diseases, except possibly the last, seem to have been imported.

There has recently been called to the writer's attention another disease, on maple leaves, new to the state and possibly to the country, that developed conspicuously in the fall of 1928. It had previously been reported only in Europe. This disease, however, unlike the others, is not likely to prove a serious trouble, since it has rarely been found and then only under unusually moist conditions and at a time in late summer when the injury is not so important as it would be earlier in the season. Dr. Deuber, of Yale, while working during vacation for the Bartlett Tree Expert Company at North Stamford, became interested in this disease and brought specimens to the writer, who started on its identification. Material was given to Dr. McCormick, of the Station's Botanical Department, and she eventually obtained in pure culture a fungus that has since been identified by Mr. Bowen as the cause of the maple disease. Mr. Bowen had in the meantime been assigned the study of this fungus, as a part of his work for a master's degree at Yale, under the writer and Dr. Deuber. Since part of Mr. Bowen's iuvestigations were carried on at the Station, where he was later employed during the summer, it was decided to publish his results as a Station Bulletin.

G. P. CLINTON.

CONTENTS

	Page
Introduction	625
Historical review	626
Review of literature	626
Synonymy and exsiccati	629
Mycological investigation	630
Leaf studies	630
Culture studies	632
Histological studies	634
Conclusion from study of leaf sections and cultures	636
Comparison with statements of others	637
Chemical treatment for shortening the rest period of potted maple trees	639
Forcing treatments	639
Results of forcing treatments	640
Inoculation of potted maple trees	643
Mycelial inoculation and infection	643
Spore inoculation and infection	644
Environmental factors in infection	644
Conclusion	645
Summary	645
Bibliography	646

A MAPLE LEAF DISEASE CAUSED BY CRISTULARIELLA DEPRAEDANS

PAUL R. BOWEN

INTRODUCTION

On September 3, 1928, Dr. C. G. Deuber of Yale University and Mr. Francis A. Bartlett of the Bartlett Tree Expert Company noticed that the trees and seedlings of the sugar maple, *Acer saccharum* Marsh., in the woods across the road from the High Ridge Country Club at North Stamford, Connecticut, possessed an unusual appearance in their foliage. At first glance it was thought that this phenomenon was a sun-scorch wilt, since the leaves exhibited very soft areas, as if they had been scalded, but observation revealed tiny white fruiting bodies of a parasitic fungus on the under surface of the affected leaves. The attack of the fungus had been very sudden, as evidenced by the color of the foliage, since no yellowing or gradual decomposition had occurred. The wilted leaves, though green, had a grayish tinge in their badly infected portions, which was due to external mycelium. Wilting was so severe at the base of many of the leaf blades that the blades hung limp from the petioles. A slight shaking of the trees caused the infected leaves to fall freely.

Such rapidity of attack by the fungus appeared to be intimately connected with the weather factors during the last week of August and the first few days of September. Weather conditions recorded by Dr. Deuber for this period are as follows: "On August 22, it rained all day and every day for the next week. Foliage of all trees remained in good condition. August 29, 30, and 31, and September 1 and 2, were very hot days with high humidity. On the night of September 2, a cloud-burst occurred at North Stamford, and on September 3, it rained all morning."

It was suspected that the rainy week of August 22-29, followed by extremely hot, humid weather presented excellent conditions for the fungous attack upon the sugar maples. The leaves had

AUTHOR'S ACKNOWLEDGMENTS. The writer wishes to acknowledge his indebtedness to Dr. G. P. Clinton and Dr. C. G. Deuber, whose direction of the work, constructive suggestions, and kindly criticism have made this publication possible. Thanks are given to Dr. Florence A. McCormick for her willing assistance and suggestions in the culture work; to Dr. H. Castle for his advice in most of the histological work; and also to Dr. A. A. Dunlap and Dr. R. P. Marshall.

become water-soaked, the temperature remained high, and the atmosphere continued to be very moist. Such conditions seemed to prove favorable for fungous activity, since seedlings, surrounded by a heavy overgrowth where the most humid condition existed, were found to be the ones most severely infected. Further discussion of the diseased condition of the sugar maple trees at North Stamford is made in a later section of this report.

HISTORICAL REVIEW

REVIEW OF LITERATURE

The organism causing the disease has been studied very little, and references to it in the literature are extremely few. This scarcity of knowledge is probably due to the fact that the malady is not of widespread occurrence, being recorded abroad in only England and Germany, and apparently never being reported before in the United States. The writer understands, however, that one or two botanists have recently observed it here, although no published accounts by these have been made. In the succeeding paragraphs the writer quotes in detail from the more important publications that have been made concerning its occurrence in Europe.

The disease was first described by Cooke (1) in 1885, in a group of short articles entitled, "Some Remarkable Moulds," read before the Quekett Microscopical Club. About six years before the reading of these articles Dr. Cooke had noticed, when in Norfolk, that several young trees of *Acer pseudo-platanus* L., growing in a damp plantation, presented an unusual appearance, from the flabbiness and decoloration of the leaves. He wrote, as follows: "The green leaves had become flaccid and rotten whilst still attached to the tree; the whole surface blotched with grayish spots, which were in many cases confluent over a great portion of the leaf. The under surface, under a pocket lens, was spotted with minute white points, like the head of a small pin. These points were most numerous on, and almost confined to, the veins of the leaf. Under the microscope, these minute points were found to be the globose capituli, or heads, of a small parasitic mould, scattered over the under surface of the leaf, with its delicate mycelium penetrating into the substance. The heads were loosely scattered, and not *collected in tufts, almost wholly confined to the venation.* The hyphae, or threads, were short, slender, flexuous, septate and swollen at the apex, where one, or three to four larger cells formed the basis of the globular head; around these large cells were clustered a number of smaller, elliptical cells, which again were sur-

mounted by somewhat triangular, obtuse-cornered cells, and these divided at the apex in a furcate manner, each fork divided off as a globose hyaline spore. Each capitulum was, in its entirety, about one-tenth of a millimetre in diameter, and the spores 12 micromillimetres.

"Some leaves were placed under glass and kept moist for weeks, when a very peculiar phenomenon was presented, the formation of small black round sclerotia on the spots occupied previously by the mould . . . The parasite is undoubtedly an injurious one, extending speedily to every leaf on young trees, ..." To this parasite Cooke gave the name of *Polyactis depraedans* Cooke.

In 1886 Saccardo (7) made reference to the article cited above from Cooke, renamed the fungus under the genus Botrytis, and gave the following (translated) description for *Botrytis depraedans* (Cooke) Sacc.: "Grayish spots on leaves, determinate to confluent; hyphae white, ascending, septate, flexuous, simple, with oblong basidia-like cells at the apex, surrounded by an outer circle of bilobed cells; with capituli globuse, subcompact; conidia globose, hyaline, 12 micromillimetres in diameter. Discovered at Norfolk, England, infecting the foliage of *Acer pseudo-platanus*, which it destroys."

Cooke (2) in 1906, again referred to the disease as follows: "*Botrytis depraedans* (Cooke). First discovered on living leaves of *Acer pseudo-platanus* in a damp wood. Several young trees had nearly every leaf affected . . . Grayish spots were formed on the leaves, which were sometimes large and confluent. The threads were flexuous and septate, simple, crowned at the apex with elliptical basidia-like cells, ultimately two-lobed. The glomerules of conidia globose and compact. Conidia globose, 12μ diam. After the leaves had fallen to the ground, and lain for a short time, numerous minute black sclerotia were formed, the ultimate development of which was never ascertained. Certainly a most destructive pest, but it does not appear to have been recognized elsewhere, at home or abroad. This parasite has never been thoroughly investigated, and, as it has occurred so seldom, there has been no opportunity for experiment on remedies."

In 1908 Saccardo (8) described a new fungus, *Illosporium Diedickeanum* Sacc. The translation follows: "Leaf spots spreading, oftentimes confluent, grayish, more distinct on the upper surface, without a border; fruiting heads very small, somewhat flattened, compact, transparently white, more numerous on the upper side, loosely scattered, 130-160μ in diam., fastened only by one point, hence easily broken off; basidia spread out from an inner almost globular cell, 30-40μ in diam., oblong cylindrical or somewhat clavate, smooth or somewhat lobed, 30-40μ long and 14μ thick, apex obtuse, conidia occasionally somewhat roughened, globular or somewhat angular, single or clustered, 13-14μ long and 10-14μ

thick, and hyaline. On leaves of *Acer pseudo-platanus,* at Steigerwald near Erfurt, Germany, Oct. 1907 (H. Diedicke).— The small fruiting bodies are quite like insect eggs. The internal structure differs from Illosporium and needs further investigation. Basidia are oftentimes seen somewhat rough at the apex."

In 1912 the following brief (translated) account was given by Sydow (13) concerning *Illosporium Diedickeanum:* ."This interesting fungus has hitherto only been known in Steigerwald near Erfurt. It was found on some trees in the park of Hohenschwangau, as well as on the Scharteweg, by Fussen, near the Tyrolean border. In both localities almost all leaves of the infected trees showed the fungus."

In 1916 von Höhnel (3) showed that *Illosporium Diedickeanum* was the same as *Botrytis depraedans.* He wrote (translated) as follows: "The author (Saccardo) in Ann. Mycol., 1908, **VI,** Bd., p. 563, Taf. XXIV, Fig. 9, described and showed this fungus, of which he had seen only the small fruiting heads (capituli), and has therefore erroneously understood and incorrectly characterized the same. It seems, therefore, that the fungus was already correctly described and classified by Cooke in 1885 as *Polyactis depraedans* [Journ. Quekett Microscop. Club, 2, Ser., II, Bd., 1885, p. 138 ff., Taf. X, Fig. 4, and Journ. Roy. Hortic. Soc., London, 1905, XXIX, Bd., p. 201 ff., Taf. XIX, Fig. 4 (n.g.)]. The fungus is, according to the original example in Sydow Mycoth. Germ. Nr. 950 and Nr. 1150 (from upper Bayern) neither an Illosporium nor a Polyactis, but a new Hyphomyceten genus which I call Cristulariella, and therefore name it *Cristulariella depraedans* (Cooke) v. H.

"This was found only on the under side of half decayed sycamore maple leaves. It appears only in such places, mostly in pallid spots, where the under leaf epidermis has been destroyed by other influences. On such places one finds in the spongy parenchyma, hyaline, thin-walled, septate, 4 to 8μ wide hyphae, mostly upright, some turned in all directions.

"Some of the hyphae ends appear on the surface and develop there straight, hyaline, 100 to 270μ long sporophores which above are 8-9, in the center 11, and on the swollen base 16μ thick The same are thin-walled and show mostly five septa, of which two are found underneath and the others more or less above. The sporophore develops above an almost round, up to 28μ wide, cell separated by a transverse wall, on which near the center, arranged in a circle, sit ten short single-celled, thin-walled, two-lobed cells, 15 to 20μ high and 12 to 15μ wide, with somewhat contracted bases.

"These bilobed cells grow in part into short and thick branched, coral-like formations, which separate further into two or three-

lobed side branches, which similarly branch. Sometimes they are rounded to about 20μ wide secondary cells, which behave in a manner quite similar to the central cell, only less plentifully. These develop also a coral-like, compressed, branch-system, which may, however, develop a pair of third lobes, which develop two to three-lobed outgrowths. From the last rounded lobes of the third and fourth orders arise finally the rounded, about 10μ large, hyaline, single-celled spores, which, as do all the branches and cells of the entire head, rest on a broad base and are separated only with difficulty.

"One understands this complicated structure of the spore head most readily when one places the same on a slide heated with caustic potash solution and subjects it to slight pressure. The branch system of the head then separates and lies in a circle around the large central cell. There is seen then mostly 10 secondary cells, each with its circle of one to two, two or three-lobed branched cell carriers with some smaller tertiary lobes surmounted by a few flaccid cells, which are cordate. The lumen of the individual cells and branches are separated from one another by transverse walls.

"The fungus cannot be considered as Cristularia (Syll. Fung. **IV**, p. 134), although it is nearly related thereto, on account of the little constricted base of the outgrowing spores, which are detached with difficulty, and the compact condition of the peculiarly constructed head."

Von Höhnel, following his description of *Illosporium Diedickeanum*, placed the fungus, as stated above, in a new genus, Cristulariella, and gave a brief description, which we translate as follows: "Cristulariella v.H. *n.g.* (Botrytidee). Parasitic Mucedineen, nutrient hyphae growing in the substratum. Fruiting hyphae upright, septate. Terminal cell large, spherical, with partially spherical, partially one to two short, two to three-lobed compact branched outgrowths, the branches of which are in part saccate. All the sac-like cells similar to the chief cell, have lobate outgrowths. Branches and cells are separated by cell walls. Spores spherical, single-celled, separated with difficulty, with a slightly narrowed base, sessile, borne singly on the tips of the ultimate branches."

SYNONYMY AND EXSICCATI

Von Höhnel in his article gave the synonymy of the fungus so completely that the writer has been unable to add others. The accepted name with synonyms and places of publication are as follows:

Cristulariella depraedans (Cooke) v. Höhn. Sitzungsber. Kais. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. I, **125**: 124. 1916.

Polyactis depraedans Cooke. Jour. Quek. Micr. Club. S. II, 2: 141-142. 1885.

Botrytis depraedans Sacc. Sacc. Syll. Fung. 4: 134. 1886.

Illosporium Diedickeanum Sacc. Ann. Mycol. 6: 563. D 1908.

Discussion of the synonymy follows later. Apparently only two exsiccati specimens have been issued, as follows: *Illosporium Diedickeanum* Sacc. Syd. Mycoth. Germ. Fasc. 19, Nr: 950. 1910. Ibid. Fasc. 23, Nr. 1150. 1912.

These few references, which were the most important of those found, were mostly of a taxonomic character, describing the fungus that caused the disease. There were even differences of opinion among the writers, concerning the description and the placing of the species in the proper genus. Very little research on the life history of the fungus has been done, so that there lies open this new field of investigation, which the writer has undertaken to unfold in the short amount of time at his disposal.

MYCOLOGICAL INVESTIGATION

LEAF STUDIES

On September 28, Dr. Clinton and the writer visited the region where the disease was first discovered, in order to observe the infected trees and seedlings, and to collect diseased leaves to be used for study. When Dr. Deuber and Mr. Bartlett discovered the fungous disease on September 3, leaves exhibiting the beginning stage showed circular, flaccid, grayish spots about one millimeter in diameter. Activity of the fungus influenced by favorable environmental conditions caused these spots to increase in size and finally merge, thus producing large, irregular, wilted portions, which covered quickly the entire area of many of the leaf blades.

By the last of September, due to much drier weather, activity of the pathogene had practically ceased. The flaccid, grayish areas of the leaves had now become grayish-brown and withered. Many of the blades cracked or were broken away from their points of attachment to the petioles. Infection had invariably followed the veins. A dropping out of the holonecrotic areas in time was common. Premature defoliation was distinctly evident, being most obvious among the tender seedlings.

On the surface of the leaves were scattered white, ball-like structures, scarcely visible to the naked eye, which resembled very much in appearance insect eggs. These structures appeared sessile, but under the microscope they proved to be fruiting heads, each borne on a short, minute stalk or sporophore. The heads were irregularly globular, somewhat flattened, and composed of rather compact cells. The sporophores were attached to very

delicate mycelial threads scantily growing on the surface. Some of the fruiting bodies appeared on the dorsal side of the leaves, but the majority were situated on the ventral side. They were sparse on some leaves and quite abundant on others, depending upon the degree of infection. Most of the fruiting bodies were located in the holonecrotic areas, but occasionally a few appeared on the adjoining green portions, which indicated that these portions were infected, but not badly enough to show plesionecrosis.

At Hurd Park, Conn., on October 10, leaves of the silver maple, *Acer saccharinum* L., were found having the same pathological condition. The blades contained grayish-brown, parched areas, but in the majority of leaves these areas were small, circular, and single, in contrast to the great number of large splotches found on the sugar maple leaves. The fruiting bodies in the necrotic regions were abundant on the top side of the leaves and rare underneath, a dissimilar condition to that of the sugar maple leaves. Adjoining green areas showed a few fruiting bodies. It seemed that the silver maple leaves were more resistant to the disease, because infection in general was neither so serious nor as widespread as it was on the leaves of sugar maples.

On October 17, at the Cathedral Pines in Cornwall, Conn., leaves of *Acer saccharum* were also found exhibiting pathogenic characteristics like those observed on the trees at North Stamford. On the same host in a ravine of the Tunxis Forest at Hartland, Conn., the disease was seen again on October 24, but the fungus was rarely in fruit on the infested leaves.

The abundance of fruiting bodies found in the grayish-brown areas and in adjoining green areas of the leaves of both species collected, and also their prominence on the dorsal and ventral surfaces for the two kinds of infected areas, are as follows:

Acer saccharum: Fruiting bodies more abundant in grayish-brown areas, few on dorsal surface, several on ventral surface; less abundant in adjoining green areas, less on dorsal surface, more on ventral surface.

Acer saccharinum: Fruiting bodies very abundant in grayish-brown areas, many on dorsal surface, very few on ventral surface; few in adjoining green areas, few on dorsal surface, very few on ventral surface.

The character of the region in which this disease was first seen at North Stamford is shown in Plate XXIX, made from a photograph by Dr. Deuber. Plate XXX illustrates the early stages of infection of the leaves of both *Acer saccharinum* and *A. saccharum*, while the later stages of injury to *A. saccharum* are seen in Plate XXXI. Through the courtesy of the officials of the Kew herbarium, Cooke's type specimen of this disease was loaned to the Experiment Station, and a photograph made of it by Dr. Marshall is shown in Plate XXXII.

CULTURE STUDIES

In order to study the organism causing the disease an attempt was made to obtain pure cultures. Sections of leaves of *Acer saccharum* approximately .5 centimeter square, each having a fruiting body on its surface, were washed in a 4 per cent formaldehyde solution and plated on oat and malt agars. Within two or three days each leaf section was covered with a copious growth of fine, downy mycelium. Transfers were made to slants of oat, potato, malt, and peptone agars, and rapid growths of the fungus resulted.

In the many transfers, vegetative growth was always rapid and abundant, consisting of fine, long, hyaline hyphae of variable but narrow widths, and exhibiting Y-shaped branching, and very few septa. All cultures were repeatedly studied in an attempt to find spores, but these rarely appeared. Later it was found that these were cultures of a Pestalozzia and, although apparently not connected with the disease, usually readily appeared in the attempts to isolate the real fungus, *Cristulariella depraedans,* which was usually crowded out by the Pestalozzia and so difficult to obtain.

At the time the disease was discovered at North Stamford, Dr. Deuber at the Bartlett Tree Research Laboratories had attempted to get cultures of the fungus. Small pieces of infected leaves were placed on agar media, and in a very few days fungal growths appeared. These cultures were sent to the Botanical Department of the Connecticut Agricultural Experiment Station for examination. There was present in all the Petri dishes the same rapidly growing fungus, exhibiting large, fluffy mycelial masses, as was obtained by the writer and previously described. Dr. Florence A. McCormick, plant pathologist of the experiment station, on examination of the cultures made by Dr. Deuber, found in one of the Petri dishes a different fungus that had previously been overlooked. This fungus was exceedingly delicate in contrast to the rapidly growing organism previously obtained, and it appeared to be very weak in mycelial production and extremely slow in growing. Dr. McCormick attempted to get this delicate, slow-growing fungus in pure culture. Failure to obtain a culture was probably due to the fact that the Petri dish cultures, made by Dr. Deuber, were rather old and the media on which they were growing had become somewhat dry. However, from diseased leaves collected at the Cathedral Pines in Cornwall, October 17, Dr. McCormick obtained cultures of the slow-growing parasite, which she kept growing during the time the writer was studying the rapidly growing fungus that he had obtained from infected leaves collected at North Stamford. The cultures of the writer and those secured by Dr. McCormick were compared, and were found to be entirely different. The mycelium of Dr. McCormick's cultures in contrast to that of the mycelium

of the other cultures was larger in width, shorter in length, and formed a more limited growth.

Since it was unknown at the time which of the two fungi had caused the infection of the sugar maple leaves, pure cultures of both were kept in active growth throughout the winter. This was done not only to study the two fungi, but with the object of using each for inoculation purposes in the spring on newly developed leaves, in order to ascertain which was the causal organism. It was thought, at this time, that perhaps one was parasitic on the other. The writer was given cultures of the slow-growing organism (Plate XXXIIIa) by Dr. McCormick,[1] and the following experiments with them were begun.

Fungous growths in Petri dishes from cultures B were produced, in which a very small number of spores was found. Thinking that perhaps differences in the degree of thickness or thinness of the media might have something to do with the formation, location, and appearance of the spores, the writer inoculated another group of Petri dishes containing media of various depths. Results indicated that the degree of thickness or thinness had no apparent effect on the cultures, only that the ones growing on the thicker media produced better vegetative growths that lasted for a longer period of time, due probably to the fact that more food was available. Eventually, an abundance of spores was produced in both groups of Petri dishes. Spore production was slow in starting in all cases.

The mycelium in the surface of the agar, in Petri dishes inoculated with cultures B, developed a very interesting but singular activity in all the media used. Very characteristic eight-sided crystals, ranging in width from 8-15 microns, were produced in the agar Plate XXXIVb.

Other Petri dishes with media of different depths were each inoculated with cultures A and B, to see whether the presence of the two fungi had any influence on each other. The fact that neither organism produced any effect upon the other seemed to indicate that no parasitism existed between them.

Further tests were made by inoculating test tubes of the various kinds of media used with cultures B. After several days all colonies had formed spores, production being greatest on potato agar, malt agar, and green bean pods. Growth of mycelium was best on potato agar, oat agar, and green bean pods, and was always more rapid and abundant on media having a high moisture content, indicating that the natural condition for infection in nature was probably a very humid atmosphere. On agar with a low water content vegetative growth was small, but spore production was hastened. Growth appeared sooner in the tubes kept in the

[1] For convenience the first cultures studied by the writer will be called cultures A (Pestalozzia), and those procured from Dr. McCormick will be designated as cultures B (*Cristulariella depraedans*).

dark than it did in those placed in the light, and seemed to be a little better. More spores were produced in the cultures left in the dark. The presence of the fungus caused the media to harden. In the older cultures black sclerotia were formed. Plate XXXIIIb, c. Potato and peptone agars were darkened by the fungus.

Externally, the fungus, cultures B, on culture media consisted at first of small, thick, rather compact, oval bunches of short, ascending, delicate hyphae. These circular, convex bunches on converging formed a dense, cottony mass whose surface was irregularly bulbous.

Microscopically, the mycelium of cultures B was hyaline, thin walled, 4-7 microns in width, sparingly branched, abruptly sinuous, with many septa. The numerous fruiting heads appeared different from those found on the surface of diseased leaves. Plate XXXIVa. They were smaller, loosely compact, composed of a cluster of basidia-like cells, from which was borne on the upper extremity of each, a small, globular conidium, 2-3 microns in diameter. Plate XXXIVb. The entire cluster rested on a larger, somewhat globular cell-like structure which was the enlarged end of the short fruiting hypha, that had become divided off by a transverse wall. The fungus, therefore, when produced on artificial media appeared to belong to the section Cristularia of the genus Botrytis as given by Saccardo.

HISTOLOGICAL STUDIES

Besides studying the two fungi, designated as cultures A and B, the writer decided to study the internal anatomy of infected leaves to help him determine which of the two fungi caused the infection. In order to do this, it was necessary to prepare and study permanent slides of diseased leaf tissues. At the time the writer collected diseased leaves at North Stamford, Hurd Park, and the Cathedral Pines, he prepared leaf sections, and the procedure for those made from diseased leaves of *Acer saccharum* from North Stamford is given below.

Pieces of the diseased leaves about .25 centimeter square were cut in the following manner: 50 from the necrotic, grayish-brown regions, each containing a fruiting body; 50 from areas where the infected portions came in contact with green areas that in all respects seemed healthy except for the presence of a few fruiting bodies; and 50 from areas that looked perfectly normal, taken far from the visibly infected portions. Fifty sections were also made from leaves of trees of the same species having no infection.

These leaf blade sections were killed and fixed in chromo-acetic acid and imbedded in paraffin. Sections, cut 10 and 16.6 microns in thickness, were stained with Pianeze IIIb, according to Vaughan (20). A study of the prepared slides of the four different groups of sections was made. Results for the groups are as follows:

1. Necrotic, grayish-brown regions. Differential staining was not at all pronounced. This was due to the fact that infected host cells reacted differently to the dye than did the cells of healthy leaf tissues, in the fact that they did not become green, but took on a more or less pink appearance, which was very similar to the color of the stained fungous mycelium.

The delicate mycelium was found mostly on the surface, which had given the grayish appearance to the infected areas. In the majority of sections fungous activity had partially disintegrated the epidermis, whereas in others the epidermal layer was completely missing. The small number of hyphae that penetrated the leaf was, for the most part, directly under the epidermis and had caused the epidermis to split off or to become loosened from the adjoining tissues. Mycelial threads, short and slightly undulating, were thin walled, septate, 4-7 microns wide, and appeared mostly curved upright, but a few strands wandered in various directions, and had broken down some of the palisade and spongy cells.

The sporophores, each bearing a single fruiting head, were turned upright to the surface of the leaf. They were simple and varied in height, the average length being 150 microns. The fruiting heads irregularly globose, somewhat flattened, 100-150 microns in diameter, presented on longitudinal section a complex structure. Plate XXXIVa. At the end of the sporophore there was a large cell, which was the swollen end of the hypha that had become divided off by a transverse wall. Produced on this basal structure was a dense ring of somewhat smaller, irregularly elliptical to club-shaped cells, which were slightly and irregularly short branched; four to six of these rings, with more or less bilobed cells terminating the upper and outermost ring, made up the compact head.

2. Infested portions in contact with green areas. The necrotic, grayish-brown areas here appeared like those described in the slides that contained leaf blade sections cut from these only. It was thought that the few fruiting bodies appearing on the green surface that adjoined the dead areas indicated that these seemingly healthy-appearing areas had mycelium from which the fruiting bodies came. The slides showed this to be true, for a few hyphae were found. Some of the tissues were slightly broken down. The fruiting bodies were like those described above. Staining appeared a little more differentiated. Host cells which were not affected as yet took on a green color, characteristic of normal leaf cells. It would seem that probably further growth of the mycelium, along with the possible secreting of acids or enzymes by the fungus, caused the tissues in these green regions to disintegrate, thus producing eventually necrotic areas.

3. Normal appearing areas on infected leaves. The normal appearing areas taken far from visibly infected portions were healthy, the leaf tissues stained green, all parts of the leaf were intact, and no mycelium was present.

4. Areas from healthy leaves. In the leaf sections made from healthy leaves all cells stained green, and were normal in position and arrangement.

Slides made with leaf sections cut from the infected sugar maple leaves obtained from the Cathedral Pines and from infected silver maple leaves collected at Hurd Park showed the same conditions as those from North Stamford.

CONCLUSION FROM STUDY OF LEAF SECTIONS AND CULTURES

A study of the prepared slides indicated that the mycelium of the organism that had injured the leaf tissues, appeared very much like that in cultures B and not at all like that of cultures A. Mycelial growth was usually scanty in the leaf tissues, and also rather sparse on the surface, which indicated a similarity in vegetative growth to that of cultures B. The hyphae appearing short, slightly undulating, thin-walled, septate, 4-7 microns wide, were also like those found in cultures B.

The fruiting bodies on the surface of the leaves, however, were different from those found in cultures B. The sporophores bearing the fruiting heads on the leaves were longer and wider than the fruiting hyphae bearing the spore heads in cultures B; those on the leaves being 100-150 microns long and 8-10 microns wide, and the fruiting hyphae in cultures B being of much shorter, variable lengths and practically the same width as that given for the mycelium in general, 4-7 microns.

The fruiting heads in the leaf sections, when under the low power of the microscope, in general appeared about as large as did those of cultures B under the high power. Those on the leaves (Plate XXXIVa) were globular, somewhat flattened, and subcompact, while those in cultures B (XXXIVb) assumed an irregular, more or less spherical form, and were loosely compact. The subcompact heads on the leaves were much more complicated than were the loosely compact ones in culture, in the fact that they were composed of more different kinds of cells and of a greater number. The clusters of cells making up both kinds of heads were produced on swollen ends of the fruiting stalks that had been partitioned off by cross walls. The cells composing the basal cluster of both kinds of heads were elongated, rather elliptical or club-shaped, but on those in the heads produced on the leaves was another cluster of irregularly branched, elongated cells, which in turn bore other similarly shaped cells, making four to six rings

of cells to each head. The basal cells of the heads in cultures B did not bear other similar cells but produced globular conidia, 2-3 microns in diameter. The terminal cells on the heads found in the leaves were not strictly globular and not 2-3 microns in diameter, but were rather heart-shaped, measuring 10-12 microns in diameter.

A comparison of cultures B with the fungus found in the prepared slides of diseased leaf sections seemed to indicate that the organism in cultures B was the fungus that had caused the infection of *Acer saccharum* and *A. saccharinum* the previous fall. The fruiting heads of cultures B with their basidia-like, basal cells bearing conidia looked like those produced in Botrytis cultures; but because of the slow and scanty growths produced, and the kind of fruiting bodies appearing on the leaves, the writer hesitated to place the organism in the genus Botrytis.

COMPARISON WITH STATEMENTS OF OTHERS

At this time a review of the literature was made. From this it seemed that the fungus that had caused the disease of our maples was the fungus described by Cooke (1) in 1885 under the name of *Polyactis depraedans,* which was later changed to *Botrytis depraedans* by Saccardo.

Saccardo, at the time of the discovery of the disease in Germany, called the fungus *Illosporium Diedickeanum.* The exsiccati specimens of *Illosporium Diedickeanum* on *Acer pseudoplatanus* examined by the writer looked like the disease on the leaves collected in Connecticut, but according to the generic description of Illosporium and other species of Illosporium observed and studied, the writer does not see how it could be called an Illosporium. Saccardo, himself, makes a statement somewhat to the effect that it differed from a true Illosporium and needed further investigation.

Von Höhnel (3), who in 1916 was the last investigator of this fungus, according to the writer's knowledge, thought that it was neither an Illosporium nor a Polyactis (Botrytis), and placed it in a new genus Cristulariella. Description by von Höhnel of the fungus under the name of *Illosporium Diedickeanum,* which he changed in this same article to *Cristulariella depraedans,* agreed better than did the other descriptions with the fungus found in the leaf tissues by the writer. It seemed evident that the fungus in the diseased tissues of the infected leaves was the same as that described by von Höhnel.

Cooke's first description of the fungus indicated that he probably had as clear an idea as any of the early workers concerning the fruiting heads. However, von Höhnel better understood their complex structure. The conidia mentioned by Cooke were given

as 12 microns in diameter. The spores produced in cultures B were 2-3 microns in diameter. Cooke, and von Höhnel as well, evidently mistook the outermost cells of the fruiting heads for spores. Apparently the true spores are rarely seen on these spore heads on the leaves.

To see whether spores were formed from the terminal cells of the fruiting heads, fruiting bodies were removed from leaves and placed in sterilized water in Van Tieghem cells. Within a few hours these terminal cells budded small conidia that were in size and shape like the spores produced in fungous growths in cultures B. Some of the conidia became detached and moved away from the terminal cells producing them, but in a short time other buds were formed, developing into conidia that were like the first ones produced. Some remained attached, and due to successive budding, short chains of conidia were formed on the fruiting cells. Many of the spores germinated while on the fruiting heads, since within a few days mycelium was found connected to the fruiting heads and extending in all directions from them. Measurements showed that the terminal fruiting cells were 10-12 microns in diameter, and that the spherical conidia were 2-3 microns in diameter. It appears from this that previous investigators were mistaken in calling the terminal cells conidia. In deciding on a name for the fungus the writer has called it *Cristulariella depraedans*. There is some doubt, however, as to whether a new genus should be made for it.

Further verification concerning the identity of the fungus was made. Cooke's type specimen of *Acer pseudo-platanus* (Plate XXXII), bearing on its lower surface a large number of fruiting bodies, was sent upon request from the herbarium of the Royal Botanical Gardens at Kew, London. This specimen was compared with the writer's diseased leaves of *Acer saccharum* and *A. saccharinum*, also with Sydow's exsiccati specimens, and the infected tissues and fruiting bodies were found to be identical. Two of the fruiting bodies were carefully removed from the English specimen, placed in a two per cent solution of potassium hydroxide to soften them and mounted in glycerin. Fruiting bodies were also removed from our pressed leaves of *Acer saccharum* and *A. saccharinum*. They were mounted in the same way as were those from the *Acer pseudo-platanus* specimen. All the heads examined appeared the same under the microscope.

It seemed certain then that the fungus found here in the diseased leaf sections was *Cristulariella depraedans*. The next step toward positive determination of its parasitic nature was to try inoculations with cultures B on growing maple leaves.

CHEMICAL TREATMENT FOR SHORTENING THE REST PERIOD OF POTTED MAPLE TREES

FORCING TREATMENTS

Work upon cultures B during the fall and early winter had progressed to a point where it was desirable to try inoculations upon growing maple leaves. Since the writer wished to make these inoculations before the regular spring leafing, forcing methods were tried in order to shorten the rest period of potted maple trees. The results of these forcing methods have been briefly reported by Deuber and Bowen (19). More complete methods and the results are given in this paper.

On October 13, the infested area at North Stamford was visited to observe the condition of the diseased trees, and to collect small trees for inoculation purposes. At this time defoliation of the infected trees was largely complete, as can be seen in Plate XXIX. Fifty small, diseased sugar maple trees from this area were secured, and transplanted to three to six inch pots in the greenhouse of the Marsh Botanical Garden, Yale University. On October 24, 50 small, healthy sugar maple trees were collected at Hartland, and potted in the same manner. Some of the transplanted diseased and healthy trees were placed outside. Others of both groups were left in the greenhouse. Complete defoliation of all the potted trees, both in the greenhouse and outside, occurred within a few weeks. From all appearances the trees had entered their normal rest period.

In order to break this dormant period and induce leafing, so that inoculations might be tried on living leaves, a series of chemical stimulation experiments was started on December 1. Ethylene chlorhydrin treatments, as used by Denny and Stanton (17, 18) for breaking the rest period of pot-grown woody plants, were followed in these investigations.

The trees were subjected to the vapors of ethylene chlorhydrin in an air tight galvanized iron can of 121.5 liters in volume. This can was kept in the preparation room of the greenhouse at temperatures of 10-18 degrees centigrade. Two concentrations of the ethylene chlorhydrin were employed, 10 and 20 milliliters for the 121.5 liter can, or one and two parts per 12,150 parts of air. A piece of cheese-cloth placed at the top of the can was moistened with the liquid ethylene chlorhydrin to provide for the volatilization of the vapors around the trees. The length of exposure of the trees varied from one to twelve days.

Trees subjected to the vapor treatments were of both the healthy and diseased groups of those kept in the greenhouse and out of doors. Checks or control plants of each were maintained. After exposure to the gas the trees were removed to the greenhouse at a temperature of 16-22 degrees centigrade, and observa-

tions were made of the time required for the leaves to unfold. The appearance of some of the trees several weeks from the time of vapor treatments with untreated checks is shown in Plate XXXVa. Plants left out of doors and not treated were placed in the greenhouse at the time that those of the same group were removed from their vapor treatments.

RESULTS OF FORCING TREATMENTS

Data for the various groups, from December 1 to March 1, concerning the number of check plants, the number of plants exposed to the gas, the time and periods of treatment, and the date of leafing were recorded. Results were tabulated to March 1 to see whether an actual forcing had been obtained. From the middle of March untreated trees left outside and in the greenhouse began to leaf. Tables 1-3 give condensed data concerning the treatments and the results obtained.

TABLE 1.[1] RESULTS OF THE FIRST AND SECOND TREATMENTS WITH ETHYLENE CHLORHYDRIN IN FORCING HEALTHY TREES OF *Acer saccharum* INTO LEAFING. LEAFING NOTED TO MARCH 1, 1929

No. of trees	Days of treatment	Date of treatment	No. of trees leafing	Date of leafing	Trees leafing per cent
First treatment					
Trees left in greenhouse					
6	1	Dec. 8-9	0		0
6	3	Dec. 9-12	2	Dec. 25	33
6	2	Dec. 13-15	0		0
Trees placed out of doors					
8	2	Dec. 13-15	0		0
12	1	Dec. 17-18	0		0
38			2		5
Second treatment					
Trees left in greenhouse					
4	5	Jan. 12-17	1	Feb. 24	25
3	5	Jan. 12-17	1	Feb. 22	33
4	5	Jan. 12-17	1	Feb. 23	25
1	12	Jan. 19-31	0		0
Trees placed out of doors					
4	5	Jan. 12-17	4	Feb. 13-23	100
2	12	Jan. 19-31	0		0
8	5	Jan. 12-17	3	Feb. 16-19	38
2	12	Jan. 19-31	2	Feb. 14-15	100
28			12		43

[1] Since none of the checks produced leaves before March 1, they are not listed in the Tables 1-3.

TABLE 2. RESULTS OF THE FIRST AND SECOND TREATMENTS WITH ETHYLENE CHLORHYDRIN IN FORCING DISEASED TREES OF *Acer saccharum* INTO LEAFING. LEAFING NOTED TO MARCH 1, 1929

No. of trees	Days of treatment	Date of treatment	No. of trees leafing	Date of leafing	Trees leafing per cent
First treatment					
Trees left in greenhouse					
3	1	Dec. 17–18	0		0
Trees placed out of doors					
4	1	Dec. 1–2	0		0
6	1	Dec. 2–3	0		0
4	2	Dec. 3–5	1	Feb. 26	25
4	3	Dec. 5–8	0		0
14	1	Dec. 12–13	1	Feb. 26	7
15	2	Dec. 13–15	0		0
50			2		4
Second treatment					
Trees left in greenhouse					
2	5	Jan. 12–17	0		0
Trees placed out of doors					
3	5	Jan. 12–17	2	Feb. 14, 26	67
3	5	Jan. 12–17	2	Feb. 15, 23	67
1	12	Jan. 19–31	1	Feb. 12	100
3	5	Jan. 12–17	2	Feb. 16, 19	67
3	5	Jan. 12–17	3	Feb. 11–13	100
4	5	Jan. 12–17	3	Feb. 12–19	75
6	12	Jan. 19–31	3	Feb. 11–24	50
3	5	Jan. 12–17	3	Feb. 12–17	100
8	12	Jan. 19–31	4	Feb. 10–24	50
36			23		64

The results of the chemical stimulation experiments to March 1, as given in Tables 1 and 2, show that the ethylene chlorhydrin was very effective in shortening the rest period of the potted maple trees. Taking all treated trees into account, more than 25 per cent leafed before March 1. None of the check trees produced leaves by that time.

The first treatment of one, two and three days' exposure to the ethylene chlorhydrin vapors did not appear to be long enough nor of sufficient concentration for shortening the rest period of sugar maple trees. Consequently, the second treatments were of five and 12 days' duration, and the concentration of the gas was doubled. The longer periods of exposure and higher concentration of gas proved to be more effective, causing some trees to unfold leaves as early as 10 days after subjection to the gas. With the five day treatment 56 per cent of the trees so treated produced leaves, while 50 per cent of those subjected to a 12 day treatment leafed in the same period. The summarized results of the five day treatment are set forth in Table 3.

TABLE 3. RESULTS OF THE FIVE DAY TREATMENTS WITH ETHYLENE CHLORHYDRIN IN FORCING TREES OF *Acer saccharum* INTO LEAFING. LEAFING NOTED TO MARCH 1, 1929

No. of trees	Date of treatment	No. of trees leafing	Date of leafing	Trees leafing per cent
Trees left in greenhouse				
Healthy				
11	Jan. 12–17	3	Feb. 22–24	27
Diseased				
2	Jan. 12–17	0		0
13		3		23
Trees placed out of doors				
Healthy				
12	Jan. 12–17	7	Feb. 13-23	57
Diseased				
19	Jan. 12–17	15	Feb. 11–26	79
31		22		71

Two explanations for the greater effectiveness of the chemical treatments in January than in December can be suggested: first, a longer period of dormancy, and, second, the increased length of exposure and increased concentration of the ethylene chlorhydrin gas. The fact that the trees kept outside showed a higher per cent of leafing than those kept in the greenhouse, indicated that the subjection to a period of low temperatures was very helpful in breaking the rest period of sugar maple trees. The trees with diseased leaves placed out of doors showed a higher percentage of leafing than the healthy trees kept outside, due, it was thought, to the earlier potting of the diseased trees, which allowed the root systems to become better established than those of the later transplanted, healthy trees. Records of the leafing of the check trees were kept. The dates ranged from March 13 to May 4. In most cases the trees kept out of doors during the winter months leafed sooner than those kept in the greenhouse.

Most of the new leaves produced on the trees whose old leaves had been diseased, were normal in size and shape, but some were slow in growing after the buds had burst. This condition indicated that, due to the premature defoliation the previous autumn, these trees had not been able to store enough food, which must be present in the new twigs in sufficient quantity for normal development of new leaves. None of the new leaves, however, produced on these trees having infected leaves the previous fall, showed any signs of the disease. This indicated that the disease was only a leaf infection, and that it was not carried over in the trees from one growing season to the next.

By means of the forcing experiments with ethylene chlorhydrin, an abundance of new leaves on the potted maples was available for inoculation experiments 30 to 60 days before the check trees leafed out.

INOCULATION OF POTTED MAPLE TREES

MYCELIAL INOCULATION AND INFECTION

Trees were inoculated on March 7 with the mycelium of the slow-growing fungus, *Cristulariella depraedans* (cultures B), secured by Dr. McCormick. In some cases a little agar along with the mycelium was transferred. It was thought that this would prevent too much drying out of the mycelium prior to its penetration of the host tissues. Some leaves were inoculated only on the dorsal surface, some on the ventral side, and others on both surfaces. Punctures with the inoculating needle were made in some leaves which, it was thought, would help to give the mycelium a better chance for more immediate penetration of the leaves.

Before inoculations were made, an abundance of wet sphagnum moss was placed on the surface of the soil in and around the pots. After inoculations, large bell jars were placed over the pots and pushed down in the moss, care being taken to leave a few openings for air to enter. The wet moss made the atmosphere around the plants very humid. It was hoped that such a moist environment would keep the surfaces of the leaves in a damp condition, would prevent the mycelium from desiccating too much before its attack on the leaves, and would stimulate growth of the fungus afterwards, since the disease was in a very damp wood when discovered, and during a rainy period in late summer. Large strips of cheese-cloth were placed over the bell jars to diffuse the light. Paper was spread over the cheese-cloth during the brightest part of the day to assure a more or less equal degree of shading. Plants placed under the same conditions but not inoculated were used as checks.

The activity of the fungus was very rapid, for on March 11, within four days after inoculation, grayish-brown spots formed on the leaves, and on March 12, characteristic white fruiting bodies appeared, some in the necrotic areas, and some in the adjoining green portions. The infected leaves continued to show all the symptoms found on diseased leaves collected the preceding autumn. Activity of the fungus was much more rapid on the leaves, its natural host, than on the artificial media, where growth generally did not appear earlier than eight to ten days.

Since cultures B had produced the infection, no inoculations were made with cultures A. The examination of permanent slides made from the infected areas of the new leaves showed that the

fungus was *Cristulariella depraedans*. The diseased condi ions of the leaves produced by artificial infection are shown in Plates XXXVb and XXXVI.

The infection of the leaves of the potted maples was found to differ with the various ways in which inoculations were made. When the mycelium was transferred along with a portion of the culture media, larger and more abundant infected areas were produced than when inoculations were made with mycelium alone. Probable reasons for this were that the presence of the media as food kept the mycelium growing before its attack on the leaf tissues, and prevented it from drying out. The ruptures made by puncturing the surface layers of the leaves also aided the hyphae to penetrate a little more readily. Leaves that were inoculated on botb sides showed greater infection than leaves inoculated on only one side. On these leaves whose inoculations had been on both sides, infection in every case occurred earlier on the ventral surface than on the dorsal surface. Inoculations made only on the ventral surface produced earlier ventral infection than dorsal infection. Likewise inoculations made on the dorsal side alone produced earlier dorsal than ventral infection. Ventral infection, however, was always more serious than dorsal. This was probably due to more moisture and less light on the ventral surface.

The results of the inoculations were almost 100 per cent infection. There were, however, a few inoculated leaves on three trees that did not become infected. Also a few leaves that were not inoculated became diseased from infected leaves. Due to the very humid atmospheric condition, produced to favor the development of the disease, molds such as Botrytis and Penicillium in a few cases appeared on the leaves whose inoculations were made along with a bit of the culture media, the media chiefly being attacked by those organisms. The leaves thus attacked were early removed. Trees badly infected with the disease were defoliated.

SPORE INOCULATION AND INFECTION

Spores secured from cultures B were placed in sterilized test tubes, each containing five cubic centimeters of sterilized tap water. These solutions were kept at ordinary room temperature. Within a day the spores had germinated. Loopfuls of the spore liquid were then transferred to the leaves of potted plants, and infection took place. Symptoms were slower in appearing than they were when the inoculation with mycelium was made.

ENVIRONMENTAL FACTORS IN INFECTION

After the infection of the inoculated trees had taken place, further observations and study were made to see whether moist condi-

tions were necessary for the infection to take place, and for the continued progress of the disease. A group of the potted trees was inoculated and exposed to the ordinary atmospheric conditions of the greenhouse. No signs of infection occurred, which seemed to indicate that a moister atmosphere than that in the greenhouse had to be present for the infection to start. Another group of the potted trees, in which infection was advancing, was removed from the humid atmosphere of the bell jars and placed in the customary environment of the greenhouse. The infected areas, instead of remaining flaccid and increasing in size, became dry and brittle and stopped spreading. These conditions seemed to indicate that more moisture had to be present for the activity of the fungus.

Some of the trees not inoculated were placed on the same bench with the inoculated and infected trees, with the result that they did not become infected. Others, not inoculated, were placed under bell jars containing infected plants. The majority of their leaves became infected. The chief difference in the environment of the last two groups was the difference in humidity of the greenhouse and the bell jars.

CONCLUSION

The disease of sugar maple trees found at North Stamford, September 3, 1928, and later elsewhere in the state, is definitely identified with *Cristulariella depraedans* as the causal organism. This conclusion is arrived at from pure cultures obtained from diseased leaves, from histological examination of diseased leaves, from comparison of our fungus with European descriptions and specimens of the above fungus, and by actual inoculation experiments with this organism upon healthy leaves.

SUMMARY

1. A disease of maple leaves apparently previously unknown in the United States, was found at North Stamford, Conn., in early September, 1928.

2. Collections of diseased leaves and small trees were made at several places in Connecticut during the autumn.

3. Pure cultures of two fungi occurring on the diseased leaves were obtained and grown on a variety of culture media and under different environmental conditions.

4. A histological study of diseased maple leaves was made. This phase of the investigation, as well as examination of typical fruiting bodies on the necrotic areas, indicated that the causal organism was *Cristulariella depraedans,* as identified by European specimens.

5. Potted sugar maple trees were forced into leafing by treatments with ethylene chlorhydrin from 30 to 60 days before leafing

of check trees, and from 60 to 90 days before leafing occurred in the field.

6. Inoculation experiments with pure cultures of *Cristulariella depraedans* on the leaves of the potted sugar maple trees produced the characteristic symptoms of the disease, as found in the field the previous autumn.

7. A condition of high humidity and warm temperatures surrounding the leaves was most satisfactory for artificial infection. This simulated the field condition of warm temperatures and the high humidity noted at the time the disease was first observed in Connecticut.

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Photograph of the locality at North Stamford where the maple leaf disease caused by *Cristulariella depraedans* was first seen.

PLATE XXX

a. *Acer saccharinum*, showing leaf in the early stage of the disease.

b. *Acer saccharum*, showing leaf in the early stage of the disease.

a. *Acer saccharum* leaf showing disease in fairly advanced condition.

b. *Acer saccharum* leaf in final stage of disease.

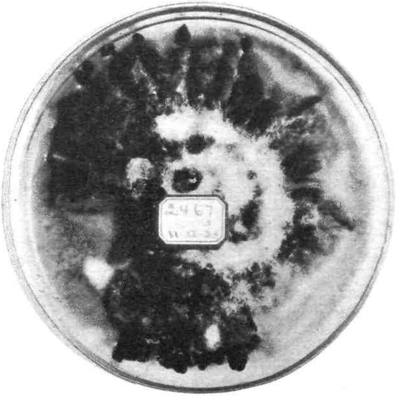
PLATE XXXII

Photograph of herbarium sheet, loaned by Kew herbarium, of Cooke's type specimen of the maple leaf disease.

PLATE XXXIII

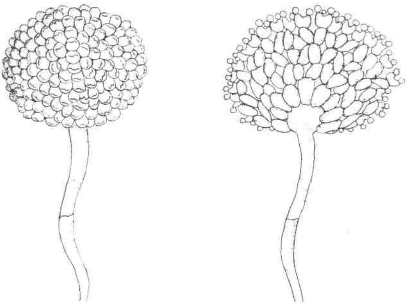
a. Young culture of the fungus *Cristulariella depraedans.*

b. Older culture showing the beginning of sclerotial development.

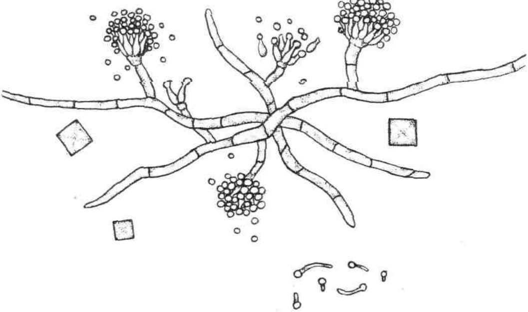


c. Old Petri dish culture with an abundant development of black sclerotia merging together in a mat.

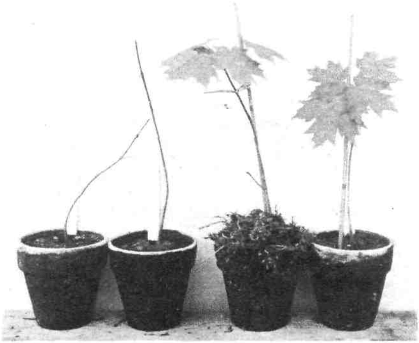
PLATE XXXIV



a. *Characteristic fruiting bodies as seen on the leaves in nature.*



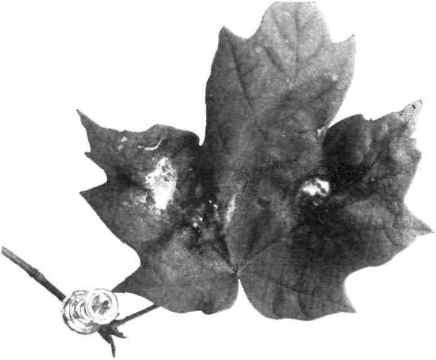
b. Mycelium, fruiting bodies, germinating spores, and crystals as seen in the artificial cultures.



a. Effect of ethylene chlorhydrin in forcing premature foliage development. First two plants, untreated checks; second two, forced plants. *Acer saccharum.*

b. General view of artificially infected plants in pots in greenhouse experiments. *Acer saccharum.*

PLATE XXXVI



a. *Acer saccharum* leaf artificially infected with mycelium in agar, showing mycelium growing on infected spots.

b. *Acer saccharum* leaf artificially infected with mycelium only; no external evidence of the mycelium, but the diseased areas more extended.

Bulletin 317 May, 1930

REPORT ON INSPECTION COMMERCIAL FEEDING STUFFS 1929

Connecticut
Agricultural Experiment Station
New Haven

The bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

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CONTENTS

	PAGE
The feed law	653
Explanation of terms used in analysis	654
Registrations	655
Inspection	676
Analyses of official samples	678
Analyses of feeds submitted by individuals	744
Miscellaneous materials	748

REGISTRATION OF FEEDS

Manufacturers, jobbers or individuals outside the State who ship concentrated commercial feeding stuffs into Connecticut are expected to register the brands so shipped and to pay the necessary fees thereon, and they generally do so. However, under the provisions of our law, if manufacturers or others outside the State neglect or refuse to register, the local dealer who handles such feeds is responsible for such registrations, registration fees and other legal requirements.

In the course of trade, feeds manufactured in another State frequently pass through the hands of several middlemen, none of whom is within the immediate jurisdiction of our law, before they reach the local distributor. This Station makes reasonable investigation to find out the source of shipment of feeds found to be unregistered, but the law imposes no obligation upon it to do so. It is the plain duty therefore of local dealers who purchase feed for resale and distribution to assure themselves that the brands they purchase are registered, or else be prepared to assume that responsibility themselves.

REPORT ON INSPECTION
COMMERCIAL FEEDING STUFFS

E. M. Bailey

THE FEED LAW

The text of the law relating to concentrated commercial feeding stuffs and of regulations made jointly by the Dairy and Food Commissioner and the Director of this Station for carrying out its provisions, are given in a special bulletin, No. 60.[1]

Some essential provisions of the law and the regulations may be briefly restated here.

Exemptions. It is held that the law exempts from classification as concentrated commercial feeding stuffs, and therefore from registration, (1) roughages such as hays, straws, corn stover, ensilage and all materials containing over 60 per cent of water; (2) whole grains and mixtures thereof; (3) meals made from whole grains when not mixed with other materials or with each other; (4) feed ground from whole grains and sold by the manufacturer directly to the consumer; (5) feed ground from materials furnished by the consumer; or (6) feed mixed according to a formula furnished by the consumer, for his own use.

Under the provision of clause 6 above, a feed must be sold as a *formula only, without a private brand name and without analysis.* But a feed cannot be offered for general trade as a formula in order to avoid registration and the registration fee.

Labelling. All concentrated commercial feeding stuffs must be labelled either by a statement printed on the bag or upon a properly attached tag; except that in the case of cottonseed meal sold for fertilizer, or of any concentrated feeding stuff sold in bulk, a certificate, which shall contain the information otherwise required to appear upon the bag or upon the tag, may be issued by the dealer in lieu thereof.

The law requires a statement of (1) the net weight of the feed contained in the package; (2) the name, brand or trademark under which the feed is sold; (3) name and address of the manu-

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Note: Analyses were made by Messrs. Nolan, Mathis and Walden; microscopic examinations by Mr. Shepard and Miss Yale; inspection and sampling by Mr. Churchill; and the compilations largely by Mrs. Vosburgh.

[1] Bull. Imm. Inf. 60, June, 1927.

facturer or importer; (4) the minimum percentages of (a) crude protein and (b) crude fat, and the maximum percentage of (c) crude fiber contained in the feed; and (5) the separate ingredients of which the feed is composed.

While the law requires only a statement of the items enumerated above, no objection will be raised to more complete statements of chemical composition.

Affixing tags. The use of wire or any metal in affixing tags to feed packages is prohibited by law.

Registration and registration fee. The law requires an annual registration of all concentrated feeds sold or offered for sale in this State. Registrations are to be made with the Connecticut Agricultural Experiment Station and beginning January 1, 1928, the registration period is for the duration of the calendar year. The registration fee is fifteen dollars ($15), for each brand, a distinct brand name or a distinct analysis constituting a distinct brand.

Duties of manufacturers, jobbers and dealers. All concentrated commercial feeding stuffs must be registered annually on January 1, or before they are offered for sale.

Manufacturers, jobbers or individuals shipping feeds into Connecticut will be expected to register their brands and pay the necessary fees thereon. Connecticut dealers should assure themselves that the brands they handle are properly registered and labelled. In case the manufacturer or jobber outside the State neglects or refuses to register, the dealer who handles such feeds will be held responsible for such registrations, registration fees and other legal requirements.

Dealers within the State who mix their own brands are responsible for the registration and proper labelling thereof.

Cottonseed meal. Cottonseed meal sold as a fertilizer is required to be registered under the terms of the fertilizer law; if sold also as a feeding stuff it is required also to be registered under the provisions of the feed law; if sold exclusively for one or the other of these purposes, it may be registered only under that law which applies.

EXPLANATION OF TERMS USED IN AN ANALYSIS OF FEEDING STUFF

In registering feeding stuffs the law requires that the minimum percentages of crude protein and crude fat, and the maximum percentage of crude fiber, shall be given; that is, the registrant must guarantee that the feeds registered will contain *not* less than the stated percentages of crude protein and of crude fat and *not more* than the stated percentage of crude fiber.

The term *crude protein* denotes those nutrients that contain

nitrogen, and is obtained by multiplying the percentage of total nitrogen in the feed by the factor 6.25.

The term *crude fat* denotes those substances that are soluble in ether and includes, besides fat, such non-fatty materials as chlorophyll and coloring matter.

The term *crude fiber* denotes the coarse, woody tissues characteristic of all forms of roughage and that are present in the outer coats of cereal and other fodder grains.

While the law requires only a statement of the three nutrients just defined, no objection is taken to more complete statements of composition, but such further statements, if given, must be correct. Thus, tags sometimes bear guaranties for nitrogen-free-extract and for carbohydrates.

The term *nitrogen-free-extract* denotes those nutrients of the starch and the sugar types. This group is never determined directly but is obtained by subtracting from 100 per cent the sum of the percentages of moisture, ash, crude protein, crude fiber and crude fat.

The term *carbohydrates* denotes the combined percentages of crude fiber and nitrogen-free-extract.

REGISTRATIONS

For the period January 1, 1929, to December 31, 1929.

One hundred and seventy-two firms and individuals have registered 876 brands of feeding stuffs. As required by Statute these registrations are listed as follows:

American Agricultural Chemical Co., New Haven Sales Dept., New Haven, Conn.

"Capital Meat and Bone Scrap"
"Protox Meat and Bone Scrap"

American Maize-Products Co., 41 East 42d St., New York City.

Cream of Corn Gluten Feed

American Milling Co., Peoria, Ill.

Amco Calf Meal
Amco Corn Feed Meal
Amco Cracked Corn
Amco Egg Mash
Amco Egg Mash with Dried Buttermilk
Amco 18% Dairy Ration (Flexible Formula)
Amco Hog Profit Feed
Amco Horse Feed
Amco June Pasture Alfalfa and Molasses
Amco Laying Mash with Alfalfa Leaf Meal
Amco Provender Pure Ground Corn and Oats ½ and ½
Amco Scratch Grains No. 1 Formula

Amco Scratch Grains No. 2 Formula
Amco Starting and Growing Mash with Dried Buttermilk
Amco 24% Batch Mix
Amco 20% Dairy Ration (Flexible Formula)
Amco 24% Dairy Ration (Flexible Formula)
Amco 12% Fitting Ration
Amco 28% Supplement Pig Meal

Arcady Farms Milling Co., 223 W. Jackson Blvd., Chicago, Ill.

Advanced Registry Dairy
Arcady Besbet Laying Mash
Arcady Scratch Grains
Arcady Stock Feed
Milkers Ready Ration
Old Colony Feed
Peerless Milk Ration
Producers Ready Ration
Sweet 16 Dairy Feed
Wonder Dairy Ration
Wonder Horse and Mule Feed
Wonder Sweet Lasses Feed

Archer-Daniels Midland Co., Minneapolis, Minn.

Pure Old Process Linseed Meal, 32%
Pure Old Process Linseed Meal, 34%

Ashcraft-Wilkinson Co., Atlanta, Ga.

Helmet Brand—Prime Cottonseed Meal
Monarch Brand—Prime Cottonseed Meal
Paramount Brand—Prime Cottonseed Meal

Atlantic Coast Fisheries Corp. of New York, 16 Exchange Place, New York City.

"Atco Fish Meal"

E. W. Bailey & Co., Montpelier, Vt.

Bailey's Open Formula 20% Dairy Feed
Bailey's Open Formula 24% Dairy Feed
Capital Dairy Ration
Capital Dairy Ration, Sweetened
Capital Mixed Feed
Favorite Dairy Ration
Favorite Dairy Ration, Sweetened
"Our Own" Dairy Ration
Pennant Scratch Feed
Pennant Stock Feed

Bay State Milling Co., Winona, Minn.

Wingold Diamond G Pure Hard Wheat Reddog
Wingold Fancy Pure Hard Wheat Mixed Wheat Feed
Wingold Pure Hard Wheat Bran
Wingold Pure Hard Wheat Flour Middlings
Wingold Rye Middlings and Rye Screenings
Wingold Standard Hard Wheat Middlings and Wheat Screenings

Beach Soap Co., Lawrence, Mass.

Beach's Star Brand Beef Scraps

Beacon Milling Co., Inc., Cayuga, N. Y.
Auburn Dairy Feed
Auburn Scratch Feed
Beacon Breeders Mash with Buttermilk
Beacon Broiler Feed
Beacon Calf Meal
Beacon Chick Feed
Beacon Complete Starting Ration
Beacon Dairy Ration
Beacon Developer Feed
Beacon Duck Fattener
Beacon Duck Starter
Beacon Egg Mash with Buttermilk
Beacon Growing Mash
Beacon Hog Feed
Beacon Horse Feed
Beacon Laying Mash
Beacon Scratch Grains
Beacon Special Scratch Grains
Beacon Starting Mash
Beacon Sweet "24"
Beacon Turkey Growing Mash
Be-Co-Lass
Cayuga Growing Mash
Cayuga Laying Mash with Buttermilk
Cayuga Stock Feed
Chariot Chick Feed
Chariot Developer Feed
Chariot Horse Feed

Ira W. Beers, Hamden, Conn.
Beers' Laying Mash
Beers' Scratch Feed

Blatchford Calf Meal Co., Waukegan, Ill.
Blatchford's Calf Meal

Amos D. Bridge's Sons, Inc., Hazardville, Conn.
Success Dairy Ration

Bristol Grain and Supply Co., Bristol, Conn.
Bristol Mash
Bristol Scratch Feed

F. W. Brode Corp., Memphis, Tenn.
"Owl Brand" 41 Cottonseed Meal
"Owl Brand" 43 Cottonseed Meal
"Owl Brand" 36 Cottonseed Meal

L. Broder Grain Store, Colchester, Conn.
L. B. Milk Ration

C. Buckingham & Co., Southport, Conn.
C. B. Dairy Feed
C. B. Growing Mash
C. B. Mash
C. B. Scratch Feed

C. E. Buell, Inc., 131 State St., Boston, Mass.
Buell-Boston Dried Skim Milk

Buffalo Flour Mills Corp., Buffalo, N. Y.
Wheat Bran

C. W. Burckhalter, Inc., 233 Broadway, New York City.
Burck-Brand Powdered Skim Milk

California Hawaiian Milling Co., San Francisco, Calif.
Chicken Greens

C. W. Campbell Co., Stonington, Conn.
Egg-O Dry Mash
Egg-O Scratch Feed
No-Botheration Dairy Ration
Provender
Xtra Vim Molasses Horse Feed

The Canada Linseed Oil Mills, Ltd., Montreal, Can.
"Maple Leaf" Linseed Oilcake Meal, 34%

A. B. Caple Co., Oregon Road, Toledo, Ohio.
Alfalfa Meal

Chapin & Company, Hammond, Ind.
Ajax Dairy Ration 16%
Ajax Dairy Ration 20%
Ajax Dairy Ration 24%
Ajax Horse Feed
Ajax Egg Mash
Ajax Scratch Feed
Centaur Fitting Ration
Chapin Kernels Grow-All
Chapin Kernels Lay-All
Chapin Kernels Start-All
Unicorn Chick Starter (with Buttermilk)
Unicorn Coarse Chick
Unicorn Dairy Ration
Unicorn Egg Mash (with Buttermilk)
Unicorn Fine Chick
Unicorn Scratch Feed

Clinton Corn Syrup Refining Co., Clinton, Iowa.
Clinton Corn Gluten Feed

Clyde Renco Milling Corp., Clyde, N. Y.
Grange Sweetened 16% Dairy Feed
Renco Farmer's Special Sweetened Feed
Renco Makempay Sweetened Feed

Coles Company, Middletown, Conn.
Fortune Chick Starter
Fortune Egg Mash with Dried Buttermilk
Fortune Growing Feed
Fortune Intermediate Scratch
Fortune Scratch Feed
Fortune Stock Feed
Fortune 20% Molasses Dairy Feed
Fortune 24% Molasses Dairy Feed

Collis Products Co., Clinton, Iowa.

Collis Process Pure Dried Buttermilk
Collis Process Pure Dried Skim Milk

The G. E. Conkey Co., Cleveland, Ohio.

Conkey's All Grain Horse and Mule Feed
Conkey's Chick Grains
Conkey's Dairy Ration 24% Protein
Conkey's Easy-Mix Rabbit Ration with Y-O
Conkey's Gecco Chick Grains
Conkey's Gecco Dairy Ration 20% Protein
Conkey's Gecco Egg Mash
Conkey's Gecco Egg Mash with Y-O
Conkey's Gecco Growing Grains
Conkey's Gecco Growing Mash
Conkey's Gecco Growing Mash with Buttermilk and Y-O
Conkey's Gecco Scratch Grains
Conkey's Growing Grains
Conkey's (The Original) Laying Mash with Buttermilk
Conkey's Scratch Grains
Conkey's (The Original) Starting Feed with Buttermilk and Y-O
Conkey's Red Seal Dairy Ration 16% Protein
Conkey's Red Seal Scratch Grains
Superior Scratch Grains

Conn. Fat Rendering and Fertilizer Corp., West Haven, Conn.

Conn. Fat Rend. & Fertz. Corp. Meat Trimmings

Consolidated By-Product Co., 30th and Race Sts., Philadelphia, Pa.

Consolidated Beef and Bone Scrap

Consolidated Rendering Co., Boston, Mass.

Corenco Bone Meal, An All Animal Feed for Cattle, Hogs and Poultry

Coöperative GLF Exchange, Inc., Peoria, Ill.

GLF Super Exchange Dairy
GLF Super Milk Maker

Copeland Flour Mills, Ltd., Midland, Ont.

Copeland's Dandy Bran
Copeland's Dandy Shorts

Corn Products Refining Co., 17 Battery Place, New York City.

Buffalo Corn Gluten Feed
Diamond Corn Gluten Meal

C. A. Cowles, Plantsville, Conn.

C. A. Blue Seal Mash
Cowles Scratch
Cowles 20% Dairy Ration
Cowles 24% Dairy Ration

Charles M. Cox Co., Boston, Mass.

Linseed Meal (Sherwin Williams Co. of Canada, Ltd.)
Rex Wheat Middlings (Maple Leaf Milling Co., Ltd., Toronto, Ont.)
Wheat Bran (Maple Leaf Milling Co., Ltd., Toronto, Ont.)

Crosby Milling Co., Brattleboro, Vt.

Crosby's Balanced Ration
Crosby's Buttermilk Baby Chick Food
Crosby's Egg Mash
Crosby's Gritless Chick Feed
Crosby's Growing Feed
Crosby's Intermediate Chick Feed
Crosby's Mixed Feed
Crosby's Ready Ration
Crosby's Scratch Feed
Crosby's Stock Feed
Crosby's Sweetened Ready Ration
Crosby's 22% Dairy Feed

R. G. Davis and Sons, Inc., New Haven, Conn.

Basic Dairy Ration
Davis Buttermilk Mash
Davis Horse Feed
Davis No. 1 Provender
Davis Scratch Feed
Davis Stock Feed
20% Open Formula

Decatur Milling Co., Decatur, Ill.

Homco Hominy Feed

Delaware Mills, Inc., Deposit, N. Y.

Delaware Chick Grains
Delaware Chick Starting Mash
Delaware Dairy Feed
Delaware Growing Mash (with Dried Buttermilk)
Delaware Laying Mash (with Dried Buttermilk)
Delaware Scratch Grains
Delaware Stock Feed
Delco 20% Dairy Feed
Double Circle Scratch Grains
Indian Laying Mash (with Dried Buttermilk)
Indian Scratch Grains

Denver Alfalfa Milling and Products Co., Lamar, Colo.

Alfalfa Leaf Meal (Leafalfa Brand)
Alfalfa Meal

Dewey Bros. Co., Blanchester, Ohio.

Corn Distillers Dried Grains

The Dominion Flour Mills, Ltd., Montreal, Que.

Wheat Bran
Wheat Shorts

Dry Milk Co., 15 Park Row, New York City.

Chikora

Duluth-Superior Milling Co., Duluth, Minn.

Boston Mixed Feed
Duluth Imperial Wheat Bran

Eastern Grain Co., Bridgewater, Mass.

Pure Dried Skim Milk Powder

Eastern States Farmers' Exchange, Springfield, Mass.

Eastern States Calf Ration
Eastern States Cottonseed Meal 41%
Eastern States Egg Mash Open Formula
Eastern States Fitting Ration Open Formula
Eastern States Fulpail Dairy Ration Open Formula
Eastern States Horse Feed Open Formula
Eastern States Milk Egg Mash Open Formula
Eastern States Milkmore Dairy Ration Open Formula
Eastern States Scratch Grains W/Coarse Cracked Corn Open Formula
Eastern States Sixteen Open Formula Dairy Ration
Eastern States Starting and Growing Mash Open Formula

S. T. Edwards and Co., Inc., Chicago, Ill.

Yankee Dried Buttermilk
Butterfly Dried Skimmed Milk

Elmore Milling Company, Inc., Oneonta, N. Y.

Chixsaver
Elmore Egg Mash
Elmore's Hog Ration
Elmore Horse Feed with Molasses
Elmore (Storrs' Formula) Laying Mash
Elmore's Makemgrow Little Pig Ration
Elmore Milk Grains
Elmore Scratch Feed
Elmore Stock Feed
Elmore's Sweet Digesto Dairy Feed
Elmore "Three Point" Calf Meal
Elmore-Waldorf Formula
Elmore's "Xtragood" Wheat Feed
Emco Feed
Emco Scratch Feed
Granger Open-Formula Ration
Otsego Economy Ration

John W. Eshelman and Sons, Lancaster, Pa.

Eshelman's Baby Chick Starter
Eshelman's Chick Feed
Eshelman Certified Fitting Ration
Eshelman Certified 20% Dairy Ration
Eshelman Certified 24% Dairy Ration
Eshelman's Conestoga 18 Dairy Feed
Eshelman's Fattening Mash
Eshelman's Golden Rod 25 Dairy Feed
Eshelman's Growing Mash
Eshelman's Lancaster 20 Dairy Feed
Eshelman's Lancaster 60 Horse Feed
Eshelman's Laying Mash
Eshelman's Open Formula 20 Dairy Feed
Eshelman's Pennsy 16 Dairy Feed
Eshelman's Red Rose 24 Dairy Feed
Eshelman's Red Rose 85 Horse Feed
Eshelman's Scratch Feed
Eshelman's Stock Feed

Eshelman's Thorobred Horse Feed
Eshelman's Wheat Flour Middlings
Eshelman's Wheat Red Dog
Eshelman Sack of Silage
Eshelman's Susquehanna Dairy Feed
Imperial Scratch Feed
Lancaster Scratch Feed
Liberty Horse Feed
Pennsy Laying Mash
Pennsy Scratch Feed

Evans Milling Co., Indianapolis, Ind.
Emco Hominy Feed

Fairchild Milling Co., Cleveland, Ohio.
Special Fine Middlings
Standard Middlings
Wheat Bran

Fairmont Creamery Co., Omaha, Neb.
Fairmont's Better Pure Flake Buttermilk

Farmers Feed Co., 532 East 76th St., New York City.
"Bull Brand" Dried Brewers Grains

Flory Milling Co., Inc., Bangor, Pa.
Cream-O-Milk Dairy Feed
Flory's Baby Chick Feed
Flory's Chick Starter
Flory's Egg Mash
Flory's Horse Feed
Flory's Scratch Feed
Golden Egg Laying Mash
National Cow Feed
Record Dairy Feed
Special Stock Feed
Sunray Scratch Feed

A. W. Forbes, East Haven, Conn.
R-Own Dairy Ration
R-Own Laying Mash
R-Own Scratch Feed

The L. T. Frisbie Co., New Haven, Conn.
Frisbie's Poultry Feed 45%
Frisbie's Poultry Feed 50%
Frisbie's Poultry Feed 55%

General Mills, Inc., Minneapolis, Minn.
Gold Medal Corn and Oat Feed No. 2
Gold Medal Hominy Feed (Guaranteed Pure)
North Star Scratch Feed—No Grit
Sonny South Hominy Feed (Louisville Milling Co., Inc.)
Washburn's Gold Medal Chick Feed—No Grit
Washburn's Gold Medal Chick Starter (with Dried Buttermilk)
Washburn's Gold Medal Developing Feed—No Grit
Washburn's Gold Medal Fancy Mixed Feed
Washburn's Gold Medal Growing Mash (with Dried Buttermilk)
Washburn's Gold Medal Hard Wheat Bran and Wheat Screenings

Washburn's Gold Medal Hard Wheat Flour Middlings and Wheat Screenings
Washburn's Gold Medal Hard Wheat Standard Middlings and Wheat Screenings
Washburn's Gold Medal Pure Hard Wheat Adrian Red Dog
Washburn's Gold Medal Scratch Feed—No Grit
Washburn's Gold Medal Vitamin Dairy Ration, containing Wheat Germ (Embryo)
Washburn's Gold Medal Vitamin Dairy Ration (24% Protein)
Washburn's Gold Medal Vitamin Egg Mash, containing Wheat Germ (Embryo)

D. H. Grandin Milling Co., Jamestown, N. Y.

Grandin's Baby Chick Feed
Grandin's Baby Chick Starter with Buttermilk
Grandin's Growing Feed
Grandin's Intermediate Chick Feed
Grandin's Laying Mash with Buttermilk
Grandin's Screened Scratch Feed
Grandin's Stock Food
Grandin's Sweetened 12 Twin Six 12 Dairy Feed
Grandin's Sweetened 20% Dairy Feed
Grandin's Sweetened 24% Dairy Feed

Gorton-Pew Fisheries Co., Ltd., Gloucester, Mass.

Gorton's Codfish Meal

Hafleigh & Company, Philadelphia, Pa.

Pure Raw Edible Bone Meal

Hales and Hunter Co., 327 So. LaSalle St., Chicago, Ill.

College Horse Feed
H & H Dairy Ration
Kingfalfa Horse Feed
Pioneer Hog Feed
Red Comb Chick Starter with Dried Buttermilk
Red Comb Duck Fattener
Red Comb Duck Grower
Red Comb *Egg Mash with Dried Buttermilk*
Red Comb Growing Mash with Dried Buttermilk
Red Comb Scratch Feed

William Hamilton & Son, Inc., Caledonia, Livingston Co., N. Y.

Wheat Bran
Wheat Middlings

The Hecker H-O Company, Inc., Buffalo, N. Y.

Re-Ground Oat Feed

Hecker-Jones-Jewell Milling Co., 40 Corlears St., New York City.

Choice Wheat Bran
H Wheat Middlings
Red Dog Flour
(Buffalo Mill)
Choice Wheat Bran
Extra Heavy Wheat Mixed Feed
Wheat Flour Middlings
Wheat Red Dog Flour
Wheat Standard Middlings

The J. C. Hubinger Bros. Co., Keokuk, Iowa.
Ke Ok uk Corn Gluten Feed

L. W. Hudson, Windsor, Conn.
"Hudson's" Cow Feed
"Hudson's" Developing Mash
"Hudson's" Laying Mash

Humphreys-Godwin Co., Memphis, Tenn.
Bull Brand Cottonseed Meal
Danish Brand Cottonseed Feed
Dixie Brand Cottonseed Meal

Imperial Grain and Milling Co., Toledo, Ohio.
Imperial Steam Cooked Feed

International Milling Co., Minneapolis, Minn.
Blackhawk Pure Wheat Bran
Blackhawk Wheat Flour Middlings
Blackhawk Wheat Low Grade Flour
Blackhawk Wheat Standard Middlings

Jersee Co., Minneapolis, Minn.
Just Right Calf Meal
Just Right Egg Mash
Just Right Growing Mash

Judith Milling Company, Lewistown, Mont.
Wheat Mixed Feed

The Kansas Flour Mills Corp., Kansas City, Mo.
Big Flake Pure Wheat Bran

Kasco Mills, Inc., Waverly, N. Y.
Apex Milk Maker
Beatsall Milk Grains

Kellogg Co., Battle Creek, Mich.
White Hominy Feed

Kelloggs and Miller, Inc., Amsterdam, N. Y.
Pure Old Process Linseed Oil Meal

Spencer Kellogg and Sons, Inc., Buffalo, N. Y.
Kellogg's Pure Old Process Linseed Meal 32%
Kellogg's Pure Old Process Linseed Meal 34%

H. H. King Flour Mills Co., Minneapolis, Minn.
"Gold Mine" Feed

Chas. A. Krause Milling Co., Milwaukee, Wis.
Badger Corn Meal (Corn Feed Meal)
Badger Horse and Mule Feed
Badger 16½% Sweet Dairy
Badger Stock Feed
Badger White Hominy Feed
Badger Yellow Hominy Feed
Blue Top Chick Feed
Blue Top Egg Mash
Blue Top Scratch Feed
Cream City Scratch Feed

S. F. Labieniec, Kensington, Conn.
Dry Mash

Land O'Lakes Creameries, Inc., Minneapolis, Minn.
Land O'Lakes Dried Buttermilk
Land O'Lakes Dried Skimmilk

The Larabee Flour Mills Co., Kansas City, Mo.
Pure Winter Wheat Bran
Winter Wheat Bran and Wheat Screenings

The Larrowe Milling Co., Box 68, North End Station, Detroit, Mich.
California Dried Beet Pulp
Dried Beet Pulp
Dried Molasses Beet Pulp
41% Protein Cottonseed Meal Prime Quality
Larro Brand Choice Cottonseed Meal
Larro Chick Grains
Larro Chick Starter
Larro Egg Mash
Larro Growing Grains
Larro Growing Mash
Larro Hog Feed
Larro Scratch Grains
Larro—The Ready Ration for Dairy Cows

C. W. Lines Co., 173 Chestnut St., New Britain, Conn.
Homestead Dry Mash
Homestead Scratch Feed
Mill Pride Dairy Ration
Mill Pride Fancy Scratch Feed
Mill Pride Milk Mash

Litchfield County Coöp. Asso., Torrington, Conn.
Common Sense Dairy[1]
Common Sense Growing Mash
Common Sense Laying Mash

Long Hill Feed Store, Long Hill, Conn.
Square Deal Buttermilk Laying Mash
Square Deal Dairy Ration

L. B. Lovitt and Co., Memphis, Tenn.
"Lovit Brand" 36% Cottonseed Meal
"Lovit Brand" 41% Cottonseed Meal
"Lovit Brand" 43% Cottonseed Meal

E. Manchester & Sons, Winsted, Conn.
Huntington Red Star Egg Mash
Red Star Dairy Feed
Red Star Egg Mash
Red Star Flour Middlings
Red Star Mixed Feed
Red Star Scratch Feed
Red Star Special Dairy Feed
Red Star Starting and Growing Mash

[1] Substituted for Common Sense Scratch Feed.

The Mann Bros. Co., Buffalo, N. Y.

The Mann Bros. Co., Pure Old Process Linseed Meal 32%
The Mann Bros. Co., Pure Old Process Linseed Meal 34%

Maritime Milling Co., Inc., Buffalo, N. Y.

Bull Brand All Mash Chick Starter Ration with Dried Buttermilk and Cod Liver Oil
Bull Brand All Mash Growing Ration with Dried Buttermilk and Cod Liver Oil
Bull Brand Chop Feed
Bull Brand Chick Feed
Bull Brand Chick Starter with Dried Buttermilk and Cod Liver Oil
Bull Brand Dairy Ration
Bull Brand Dairy Ration, Sweetened
Bull Brand Daisy Scratch Feed
Bull Brand Developing Feed
Bull Brand Growing Mash with Dried Buttermilk and Cod Liver Oil
Bull Brand Heavy Mixed Feed
Bull Brand Hi-Test Dairy Feed, Sweetened
Bull Brand Horse Feed with Molasses
Bull Brand Laying Mash with Dried Buttermilk
Bull Brand Marmico Dairy Feed with Molasses
Bull Brand Red-E-Mixt Dairy Feed, Sweetened
Bull Brand Red-E-Mixt Egg Mash
Bull Brand Scratch Feed
Bull Brand Stock Feed
Bull Brand Wheat Flour Middlings
Jersey Dry Mash

A. G. Markham and Co., Springfield, Mass.

Cooked Meat and Bone Scrap 45%
Cooked Meat and Bone Scrap 50%

The Geo. E. Marsh Co., Lynn, Mass.

Marsh's Diamond Special Scraps for Poultry
Marsh's Pure Ground Scraps for Poultry

C. J. Martinis Grain Co., L-3 Produce Exchange, New York City.

Alco Dried Brewers Grains
Alco Dried Distillers Grains

Meader Milling Co., Inc., Hoboken, N. J.

Green Velvet Feed
Purifine Linseed Oil Meal

Meech and Stoddard, Inc., Middletown, Conn.

Red Wing Dairy Ration
Red Wing Dairy Ration 20% with Brewers Grains
Red Wing Dairy Ration 24% with Brewers Grains
Red Wing Mixed Feed
Red Wing Molasses Horse Feed
Red Wing Special Buttermilk Chick Starter
Red Wing Special Buttermilk Growing Feed
Red Wing Special Buttermilk Laying Mash
Red Wing Special Chick Feed
Red Wing Special Dairy Ration
Red Wing Special Intermediate Chick Feed
Red Wing Special Scratch Feed
Red Wing Stock Feed

Memphis, Cottonseed Products Co., Memphis, Tenn.

Durham Thirtysix Cottonseed Meal
Durham Fortyone Cottonseed Meal
Durham Fortythree Cottonseed Meal

Mennel Milling Co., Toledo, Ohio.

Corn Feed Meal
Memo All Grain Horse Feed
Memo All Mash Ration
Memo Chick Scratch
Memo Dairy Feed
Memo Egg Mash
Memo 16% Sweet Dairy Feed (with Molasses)
Memo 22% Milk Ration
Mennel's Fancy Bran
Mennel's Mixed Grains[1]

Middleport Flour Mills, Inc., Middleport, N. Y.

Angelus Wheat Bran
Angelus Wheat Middlings

Milmine, Bodman & Co., Inc., 115 Produce Exchange, New York City.

Dried Beet Pulp

Miner-Hillard Milling Co., Wilkes-Barre, Pa.

No. 1 Scratch Feed
Rye Middlings
"1795" Steam Cooked Corn and Oats
Steam Cooked Hominy Feed

Geo. Q. Moon & Co., Inc., Binghamton, N. Y.

Moon's Baby Chick Grains
Moon's Baby Chick Starter Mash
Moon's Developing Grains
Moon's Fresh Ground Mixed Feed
Moon's Fresh Ground White Middlings
Moon's Hominy Feed
Moon's Laying Mash with Dried Buttermilk
Moon's Scratch Feed
Moon's Special A Laying Mash with Dried Buttermilk
Moon's Stock Feed
Moon's 20% Dairy Feed with Molasses
Moon's 24% Dairy Ration
Moon's Wheat Bran
Moon's X Dairy Ration

Moran-Patton Co., 234 Cedar St., New Haven, Conn.

C-B Mash

Fred C. Morse, Guilford, Conn.

Old Mill Dairy Feed
Old Mill Fitting Feed
Old Mill Growing Mash
Old Mill Horse Feed
Old Mill Laying Mash
Old Mill Laying Mash with Milk
Old Mill Provender
Old Mill Scratch Feed
Old Mill 20% Dairy Feed

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[1] Substituted for Memo Scratch Grains.

Jas. F. Morse and Co., Somerville, Mass.
- Morse's Meat Scraps 40%
- Morse's Meat Scraps 50%

Mt. Vernon Milling Co., Mt. Vernon, Ind.
- Poco Hominy Feed

National Milling Co., Toledo, Ohio.
- National Feed
- Osota
- Pure Wheat Bran

Nebraska Consolidated Mills Co., Omaha, Neb.
- Pure Wheat Bran
- Pure Winter Wheat Midds

New England By-Products Corp., 20 West St., Lawrence, Mass.
- Blue Seal Meat Scraps
- Gold Seal Dried Skim Milk
- White Seal Meat Scraps

Newman Bros. Grain Co., Rochester, N. Y.
- Corn Feed Meal
- Genesee Scratching Grains
- Mystic Chick Feed
- Mystic Chick Starter with Buttermilk
- Mystic Growing Mash with Buttermilk
- Mystic Intermediate Feed
- Mystic Laying Mash
- Mystic Stock Feed, Sweetened

Newsome Feed and Grain Co., Carson Station, Pittsburgh, Pa.
- Palmo Midds

Newton Feed Co., Milwaukee, Wis.
- Newtrio Growing and Fitting Ration
- Newtrio 20% Dairy Ration

Niagara Falls Milling Co., Niagara Falls, N. Y.
- Niagara Choice Wheat Bran
- Niagara Choice Wheat Middlings

The Northwestern Consolidated Milling Co., Minneapolis, Minn.
- Planet Feed
- Pure Wheat Bran
- Wheat Flour Middlings
- Wheat Mixed Feed
- Wheat Standard Middlings
- XXX Comet

Nowak Milling Corp., Hammond, Ind.
- Domino Developing Feed
- Domino Laying Mash with Buttermilk
- Domino Scratch Feed
- Domino 24½% Dairy Feed
- Domino Vim-O-Lene Horse Feed
- Fidelity Stock Feed
- Marathon Chick Feed

Ogilvie Flour Mills Co., Ltd., Montreal, Que.

Ogilvie's Oat Feed
Ogilvie's Wheat Bran
Ogilvie's Wheat Shorts

Ontario Milling Co., Inc., Oswego, N. Y.

Aunt Mary's Chick Starting Mash with Dried Buttermilk
Aunt Mary's Coarse Chick Feed
Aunt Mary's Egg Mash with Dried Buttermilk
Aunt Mary's Fine Chick Grains
Aunt Mary's Scratch Feed
Aunt Mary's Special Growing Mash with Dried Buttermilk[1]
Big Value Dairy Feed
Big Value Dairy Feed with Molasses
Big Value Horse Feed with Molasses
Butterfat Dairy Feed with Molasses
Oswego Egg Mash with Meat and Fish
Oswego Scratch Feed
Oswego 16% Dairy Feed with Molasses
Uncle John's Stock Feed with Molasses
Uncle John's 24% Cream Pot Ration

S. V. Osborn Est., Branford, Conn.

Osborn Mash
Osborn Provender
Osborn Scratch

Park & Pollard Co., Buffalo, N. Y.

Belmont Horse Feed
Bet-R-Milk 20% Ration
Bidwell Dry-Mash (Black Rock Milling Corporation)
Bidwell Scratch Feed (Black Rock Milling Corporation)
Bison Stock Feed, Sweetened
Chelsea Horse Feed
Claco Dairy Ration (C. L. Adams Co.)
Corn and Oats ½ and ½
Feed Meal
Fitting Ration
Go Tu It Pig and Hog Ration
Growing Feed
Herdhelth 16% Ration
Intermediate Chick Feed
Lay or Bust Dry-Mash
Leghorn Special Dry-Mash
Milkade Calf Meal
Milk-Maid 24% Sweetened Dairy Ration
Overall 24% Dairy Ration
Over the Top Scratch
Park & Pollard Chick Scratch
Park & Pollard Chick Starter
Park & Pollard Stock Feed
Park & Pollard Horse Feed
Red Ribbon Chick Feed
Red Ribbon Scratch Feed
Top Notch 16% Ration
Wheat Flour Middlings

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[1] Substituted for Aunt Mary's Growing Mash with Dried Buttermilk.

The Patent Cereals Co., Geneva, N. Y.
Hominy Feed

Pecos Valley Alfalfa Mills Co., Hagerman, N. M.
Velvet Meal

Pillsbury Flour Mills Co., Minneapolis, Minn.
Palisade Scratch Feed
Pillsbury's Dairy Ration
Pillsbury's Durum Wheat Bran and Screenings
Pillsbury's Fancy Mixed Feed and Screenings
Pillsbury's Hard Wheat A Middlings and Screenings
Pillsbury's Hard Wheat Bran and Screenings
Pillsbury's Hard Wheat Standard B Middlings and Screenings
Pillsbury's Rye Middlings and Screenings
Pillsbury's Wheat Bran
Pillsbury's Wheat Gray Shorts
Pillsbury's XX Daisy

Pittsburgh Plate Glass Co., Newark, N. J.
Red Wing Linseed Meal

The Frank S. Platt Co., New Haven, Conn.
Platco Laying Mash
Platco Perfection Grain Mixture

Postum Co., Inc., Battle Creek, Mich.
Burt's Dairy Feed
Burt's Hominy Feed

W. N. Potter and Sons, Inc., Greenfield, Mass.
A. D. P. 24% Dairy Ration
Puritan Dry Mash
Puritan Growing Feed
Puritan Scratch Feed

Pratt Food Co., Hammond, Ind.
Pratt's Baby Chick Food with Buttermilk
Pratt's Circle A Chick Scratch Feed
Pratt's Circle A Large Scratch Feed
Pratt's Supreme Dairy Feed
Pratt's Supreme Fattening Mash with Buttermilk
Pratt's Supreme Growing Mash with Buttermilk
Pratt's Supreme Laying Mash with Buttermilk
Pratt's Supreme Stock Feed
Pratt's Sweet 24% Dairy Feed
Pratt's Utility Horse Feed
Pratt's Utility Large Scratch Feed
Pratt's Victory Intermediate Scratch Feed
Pratt's Victory Chick Scratch Feed
Pratt's Victory Large Scratch Feed
Pratt's Victory Laying Mash with Buttermilk
Pratt's White Hominy Feed (Buffalo Mill)

H. C. Puffer Co., Springfield, Mass.
Egg-Em-On Growing Feed
Egg-Em-On Laying Mash
Egg-Em-On Scratch Feed
Producer Dairy Feed
Sweetened Producer Dairy Feed

The Quaker Oats Co., 80 East Jackson St., Chicago, Ill.

Banner Feed
Bell Cow Bran
Bell Cow Shorts
Big Egg Scratch Grains, No Grit
Buckeye Feed
Hominy Feed
Horse Power Feed
Quaker Ful-O-Pep Chick Starter
Quaker Ful-O-Pep Coarse Chick Feed
Quaker Ful-O-Pep Egg Mash
Quaker Ful-O-Pep Fine Chick Feed
Quaker Ful-O-Pep Growing Mash
Quaker Ful-O-Pep Scratch Grains
Quaker Ful-O-Pep Station Grade Fattening Feed
Quaker Green Cross Horse Feed
Quaker Schumacher Feed
Quaker 16% Protein Dairy Ration
Quaker Sugared Schumacher Feed
Quaker 20% Protein Dairy Ration
Quaker 24% Protein Dairy Ration
Richford Provender
Richford White Diamond Stock Feed
Schumacher Calf Meal
Schumacher Little Chick Feed, No Grit
Schumacher Scratch Grains, No Grit
Sugared Vim Feed
Vim Feed
White Hominy Feed
White Star Stock Feed, Fine
Yellow Hominy Feed

Ralston Purina Co., St. Louis, Mo.

Buffalo Purina Bulky Las Feed
Corn Feed Meal
Fine Ground Poultry Alfalfa Meal
Protena Dairy Feed
Protena 20% Dairy Feed
Purina Baby Chick Chow Feed
Purina Blue Checker Cow Chow Feed
Purina Blue Checker Grainola Feed
Purina Calf Cow Feed containing Mineral
Purina Checkerboard Rolled Oats (steam cooked)
Purina Chicken Chowder Feed containing Mineral
Purina Chicken Fat Chow Feed containing Mineral
Purina Chicken Fatena Feed containing Mineral
Purina Chick Grow Chow Feed containing Mineral
Purina Chick Growena Feed containing Mineral
Purina Chicken Startena Feed containing Mineral
Purina Cow Chow Feed
Purina Fitting Chow Feed
Purina Hen Chow Feed
Purina Intermediate Hen Chow Feed
Purina Hog Fatena Feed containing Charcoal
Purina Lamb Chow Feed containing Charcoal
Purina Lay Chow Feed containing Mineral
Purina Omolene Feed
Purina Orange Checker Cow Chow Feed

Purina Pig Chow Feed containing Charcoal
Purina Red Checker 34% Cow Chow Feed
Purina Red Checker Grainola Feed
Purina Steer Fatena Feed containing Charcoal
Purina Stock Feed
Winner Scratch Feed

John Reardon and Sons Co., Cambridge, Mass.

Register Brand Meat and Bone 45%
Register Brand Meat and Bone 55%

The Red Wing Milling Co., Red Wing, Minn.

Red Wing Special Wheat Bran

Robin Hood Mills, Ltd., Moose Jaw and Calgary, Canada.

Superior Pure Wheat Bran
Superior Pure Wheat Shorts

Rockville Grain and Coal Co., Rockville, Conn.

Diamond Dairy Ration
Diamond Horse Feed
Diamond Intermediate Chick Feed
Diamond Laying Mash
Diamond Scratch Feed

The Rogers and Hubbard Co., Portland, Conn.

Edible Bone Flour for Cattle and Poultry
Edible Steamed Bone

Fred H. Rolf, Inc., Guilford, Conn.

Hubbard's Egg Producer
Rolf's Chic Grains
Rolf's Chic Mash
Rolf's Scratch Grains

Royal Milling Co., Great Falls, Mont.

Dependable Rex Hard Wheat Bran
Dependable Rex Hard Wheat Mixed Feed

Russell-Miller Milling Co., Minneapolis, Minn.

Alta Hard Wheat Middlings
Hard Wheat Occident Bran
Hard Wheat Occident Mixed Feed

Russia Cement Co., Gloucester, Mass.

Chic-Chuk, "The Ideal Concentrated Poultry Food"

A. W. Scott Co., San Francisco, Calif.

Atlas Poultry Greens

Seymour Grain and Coal Co., Seymour, Conn.

See More Egg Mash Buttermilk
See More Egg Scratch Feed
See More Milk Dairy Feed

Shelton Feed Co., 73 Bridge St., Shelton, Conn.

Nelson's Laying Mash
Nelson's Mixed Chicken Feed

M. L. Shoemaker and Co., Inc., Philadephia, Pa.
Shoemaker's "Swift Sure" 50% Meat and Bone Scrap

W. G. Slugg, Milwaukee, Wis.
Slugg's Pure Dried Skimmilk

Winchell Smith, Inc., Farmington, Conn.
Mill Streams "Boomerang" Dairy Feed
Mill Streams "Fortune Hunter" Scratch Grains
Mill Streams "Lightnin" Laying Mash
Mill Streams "Twenty Per Cent" Dairy Ration

Ike Sovitsky, Ansonia, Conn.
Ansonia Dairy Ration
Ansonia Egg Mash with Buttermilk
Ansonia Scratch Feed
Ansonia Stock Feed

Spratt's Patent (Am.) Limited, Newark, N. J.
Spratt's Chicgrain
Spratt's Mash Food with Buttermilk

Springfield Rendering Co., Springfield, Mass.
Springfield Poultry Feed

A. E. Staley Mfg. Co., Decatur, Ill.
Staley's Corn Gluten Feed

Standard Milling Co. of Canada, Ltd., 67 Yonge St., Toronto, Ont.
Bran
Shorts

John T. Stanley Co., Inc., 642 West 30th St., New York City.
Stanley's Meat and Bone Scrap

St. Albans Grain Co., St. Albans, Vt.
Brewers' Dried Grains
Charlestock
Hygrade 16 Sweetened Milk Ration
Hygrade 20 Sweetened Milk Ration
Hygrade 24 Sweetened Milk Ration
King Baby Chick Food (containing Cod Liver Meal-Buttermilk)
King Chick Feed
King Dairy Feed with Beet Pulp, Sweetened
King Growing Feed (containing Buttermilk)
King Horse Feed
King Intermediate Chick Feed
King Mash Feed (containing Buttermilk)
King Scratch Feed
King Stock Feed
King 22 Milk Ration, Sweetened
Paragon Dairy Feed
Paragon Dairy Feed, Sweetened
Paragon Hominy Feed
Paragon Scratch Feed
Wirthmore All Grain Chick Feed (Fine Chick Scratch)
Wirthmore Baby Chick Starter (containing Cod Liver Meal-Buttermilk)
Wirthmore Calf Meal

Wirthmore Dairy Feed with Beet Pulp
Wirthmore Dairy Feed with Beet Pulp, Sweetened
Wirthmore 14 Fitting Ration
Wirthmore Flour Middlings
Wirthmore Growing Feed (containing Buttermilk)
Wirthmore Hog Feed
Wirthmore Horse Feed
Wirthmore Intermediate Chick Feed (Coarse Chick Scratch)
Wirthmore Laying Mash (containing Buttermilk)
Wirthmore Pig Feed
Wirthmore 16 Dairy Ration
Wirthmore 16 Dairy Ration, Sweetened
Wirthmore Scratch Feed
Wirthmore Stock Feed
Wirthmore 20 Dairy Feed
Wirthmore 20 Dairy Feed, Sweetened
Wirthmore 25 Balanced Ration
Wirthmore 25 Balanced Ration, Sweetened
Wirthmore Turkey Starter (containing Cod Liver Meal-Buttermilk)
Wirthmore Wheat Feed

St. Lawrence Flour Mills Co., Ltd., Montreal, Que.
Bran

Chas. M. Struven and Co., Baltimore, Md.
Struven's Fish Meal

Syracuse Milling Co., Syracuse, N. Y.
Jordan Horse Feed with Molasses
Onondaga Dairy Feed
Onondaga Scratch Grains
Symco Scratch Grains
Syragold Chick Feed
Syragold Chick Starter
Syragold Dairy Feed
Syragold Egg Mash
Syragold Feed Meal
Syragold Flour Middlings with Mill Run Screenings
Syragold Ground Corn and Oat Feed
Syragold Growing Mash
Syragold Horse Feed with Molasses
Syragold Laying Mash with Buttermilk
Syragold Milk Ration
Syragold Scratch Grains
Syragold Stock Feed

D. L. Talcott, Torrington, Conn.
Economy Dairy Ration

Thomaston Supply Co., Thomaston, Conn.
Thomaston Dairy Ration
Thomaston Egg Mash
Thomaston Scratch

Tioga-Empire Feed Mills, Inc., Waverly, N. Y.

Chicatine
Colonel's Ration
Derby Corn and Oat Feed
Derby-E-Gee Scratch Feed
Derby Meal
Egatine
E-Gee Dairy Feed
E-Gee Laying Mash
E-Gee Stock Feed
Neverfail Horse Feed
Or-Co Feed
Red Brand Ti-O-Ga Dairy Feed
Ti-O-Ga Calf Food
Tioga-Chick and Growing Mash
Ti-O-Ga Laying Food
Tioga-Neverfail Chick Grains
Tioga-Neverfail Growing Grain
Tioga-Neverfail Poultry Grain
White Brand Tioga Dairy Feed

Trader's Feed and Grain Co., Inc., Buffalo, N. Y.

Bonny Hard Wheat Bran and Screenings

Ubiko Milling Co., Cincinnati, Ohio.

Crusader Horse Feed
Ubiko All-Mash Complete Laying Ration
Ubiko All-Mash Developer
Ubiko Union Grains 20% Sweet Dairy Ration
Ubiko Union Grains 24% Sweet Dairy Ration
Union Grains Ubiko Biles Ready Dairy Ration

United Mills Co., Inc., Grafton, Ohio.

U. M. C. Wheat Middlings

Union Sales Corp., Columbus, Ind.

Union Corn Gluten Feed

Upper Hudson Rye Flour Mills, Inc., Troy, N. Y.

Rye Feed

Vitality Mills, Inc., 166 West Jackson Blvd., Chicago, Ill.

Advance 16% Dairy Feed with Molasses
Advance 20% Dairy Feed
Special Rosebro Horse Feed
Vitality Chick Starter
Vitality Egg Mash
Vitality Fine Chick Scratch
Vitality Scratch Feed (No Grit)
Vitality 20% Dairy Feed with Molasses
Vitality 22% Dairy Feed with Molasses
Vitality 24% Dairy Feed with Molasses
Will-Pay Dairy Ration

Wadsworth Feed Co., Warren, Ohio.

Wadfeeco Dairy Ration
Wadsworth's Special Dairy Ration

Wayne Feed Mills, Fort Wayne, Ind.
- Jumbo Dairy Feed
- Wayne All Mash Chick Starter
- Wayne Calf Meal
- Wayne Dairy Feed
- Wayne Egg Mash
- Wayne Scratch Feed
- Wayne Supreme Horse Feed
- Wayne 20% Dairy Feed

F. S. Wertz and Son, Reading, Pa.
- Colonial Mixed Grains for Poultry
- Wertz's Horse Feed with Alfalfa and Molasses

Wolverton Flour Mills Co., Ltd., St. Mary's, Ont.
- Wolmacs Pure Wheat Bran

Worcester Rendering Co., Auburn, Mass.
- P. W. Meat Scrap
- P. W. Special Meat Scrap

Yantic Grain and Products Co., Norwich, Conn.
- Abington Dairy Feed
- Almo
- Big (Y) Dairy Ration
- Big (Y) Flour Middlings
- Big (Y) Growing Feed
- Big (Y) Horse Feed[1]
- Big (Y) Laying Mash
- Big (Y) Laying Mash with Buttermilk
- Big (Y) Mixed Feed
- Big (Y) Scratch Feed[1]
- Uncas Dairy Feed
- Uncas Scratch Feed
- Uncas Stock Feed
- Uncas Sugared Stock Feed[1]

INSPECTION

The inspection herein reported upon covers the calendar year of 1929.

The Station inspector visited 146 dealers in 97 towns of the State and took 700 samples, including all of the registered brands that could be found on sale. Because some were second samples of brands already examined, not all of these official samples were analyzed.

A total of 947 samples of feeding stuffs and other fodder materials were examined, of which number 646 were for purposes of *official inspection, 178 for the Storrs Agricultural Experiment* Station in connection with field experiments and feeding trials, and 123 were submitted by individuals. Results of the analyses made for the Storrs station are not included in this report.

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[1] Takes the place of one of three feeds discontinued during the year, namely, Echo Dairy Feed, Perfection Dairy Feed and Ging'm Gal Scratch Feed.

The tabulated summary of inspection shows that of the total number of official samples examined 85 per cent met the guaranteed analyses under which they were sold. This is a gain over last year when the corresponding percentage was 78. Considering individual guaranteed items, there being three (protein, fat and fiber) for each sample, there were 1938 guaranties and 117 deficiencies were found, which shows that 94 per cent of these guaranties were met as compared with about the same figure last year, 92 per cent.

Our law makes it illegal to affix tags to sacks of feed by means of wire or other metallic device. Only two instances of violation of this requirement were found in the inspection two years ago, and during the past year no violations of this provision were discovered.

Microscopic examinations have revealed no instance of serious contamination with weed seeds or other deleterious materials. In the main the declarations of ingredients have been substantiated by our examinations. Conclusions as to the presence of undeclared ingredients or the absence of declared ingredients are often complicated by revisions of formulas made from time to time subsequent to original registrations.

Analyses of official samples are given in Table I, page 678, and those of unofficial samples submitted for the usual analysis in Table II, page 744.

SUMMARY OF INSPECTION

Feed	Samples examined	Samples deficient	Deficiencies in			Total deficiencies
			Protein	Fat	Fiber	
Cottonseed meal	5	1	1	1	0	2
Linseed meal	9	0	0	0	0	0
Wheat bran	28	0	0	0	0	0
Wheat middlings	12	0	0	0	0	0
Wheat red dog	3	0	0	0	0	0
Wheat feed (mixed feed)	14	0	0	0	0	0
Corn gluten feed	7	2	1	1	0	2
Hominy feed	15	0	0	0	0	0
Rye products	2	0	0	0	0	0
Brewers' & distillers' grains	4	1	1	0	0	1
Dried beet pulp	3	0	0	0	0	0
Horse feed	58	6	1	2	3	6
Dairy feeds	148	39	11	33	6	50
Stock feeds	34	4	0	3	2	5
Calf feed, etc.	18	4	1	4	0	5
Poultry feeds	245	35	6	25	7	38
Beef scrap, etc	41	8	5	3	0	8
Total	646	100	27	72	18	117

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
					Protein (N x 6.25)		Fiber			Fat	
			Water	Ash	Found	Guaranteed, not less than	Found	Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Found	Guaranteed, not less than
	OIL SEED PRODUCTS		%	%	%	%	%	%	%	%	%
	Cottonseed Meal										
2512	*Helmet.* Ashcraft-Wilkinson Co., Atlanta, Ga.	*Westerly:* C. W. Campbell Co.	6.80	6.59	41.00	41.00	9.65	10.00	29.63	6.33	5.50
*1187	*Owl 36%.* F. W. Brode Corp., Memphis, Tenn.	*Colchester:* P. Cutler, Inc.	5.75	6.75	35.38	36.00	13.40	14.00	33.42	5.30	4.00
2704	*Owl 41%.* F. W. Brode Corp., Memphis, Tenn.	*Simsbury:* Woods-Chandler Co.	8.00	6.83	39.94	41.00	10.60	10.00	28.48	6.15	10.00
2633	*Danish.* Humphreys-Godwin Co., Memphis, Tenn.	*Seymour:* Seymour Grain & Coal Co.	6.40	6.20	37.25	36.00	12.83	15.00	29.94	7.38	5.00
2585	*Dixie.* Humphreys-Godwin Co., Memphis, Tenn.	*Ansonia:* I. Sovitsky Grain & Coal Co.	6.48	7.43	51.63	41.00	8.93	10.00	28.30	7.23	5.00
	Linseed Meal										
2452	*Pure Old Process.* Archer-Daniels-Midland Co., Minneapolis, Minn.	*Branford:* S. V. Osborn Est.	9.85	6.36	31.88	32.00	8.35	9.00	38.56	5.00	5.00
2599	*Maple Leaf 34%.* Canada Linseed Oil Mills, Montreal, Canada	*Lebanon:* Berkman Grain Co.	8.80	6.38	33.75	34.00	7.85	9.00	37.49	5.73	5.00

2579	Chas. M. Cox, Boston, Mass. ...	*Shelton:* Wolf Savitsky	7.35	8.10	35.88	35.00	7.20	7.50	32.97	8.50	6.50
1092	*Pure.* Kellogg & Miller, Amsterdam, N. Y.	*Southbury:* H. R. Stone	7.45	6.28	34.75	34.00	8.40	9.00	37.12	6.00	5.00
1037	*Old Process.* Spencer Kellogg & Sons, Edgewater, N. J.	*Guilford:* Fred C. Morse & Son	8.65	6.86	32.00	32.00	8.00	10.00	38.09	6.00	5.00
1039	*Old Process.* Spencer Kellogg & Sons, Buffalo, N. Y.	*East Haven:* F. A. Forbes	8.00	5.44	34.50	34.00	8.15	10.00	38.53	5.38	5.00
2842	*The Mann Bros. Co. Pure Old Process.* Mann Bros. Co., Buffalo, N. Y.	*Danielson:* Young Bros. Co.	10.75	6.06	32.25	32.00	7.83	10.00	35.78	7.33	6.00
2841	*The Mann Bros. Co. Pure Old Process.* Mann Bros. Co., Buffalo, N. Y.	*Stamford:* Clapboard Hill Feed Co.	8.83	5.81	33.50	34.00	7.96	10.00	37.55	6.35	6.00
2885 •	*Red Wing.* Pittsburgh Plate Glass Co., Pittsburgh, Pa.	*Long Hill:* Long Hill Feed Store	8.73	5.63	35.63	32.00	7.68	9.00	36.03	6.30	5.00
	WHEAT PRODUCTS										
	Wheat Bran										
1004	Chas. M. Cox, Boston, Mass. ...	*Hamden:* Ira W. Beers	9.05	6.09	16.81	13.50	9.60	11.50	52.30	6.15	3.50
2589	Dominion Flour Mills, Montreal, Canada	*Rockville:* Rockville Grain & Coal Co.	9.75	6.34	14.50	14.50	10.25	11.50	53.68	5.48	3.50
2795	*Duluth Imperial.* Duluth Superior Milling Co., Duluth, Minn.	*Windsor:* L. W. Hudson	11.18	6.24	16.25	14.00	8.38	13.00	52.52	5.43	3.75
2490	*Washburn's Gold Medal.* General Mills, Inc., Minneapolis, Minn.	*Colchester:* Red Wing Feed & Lumber Co.	11.33	6.72	15.44	14.00	9.13	12.00	52.60	4.78	4.00
1086	*Choice.* Hecker - Jones - Jewell Milling Co., Buffalo, N. Y. ...	*East Bridgeport:* J. Simon	9.20	6.92	15.50	13.50	10.15	11.50	52.70	5.53	3.50
2673	*Choice.* Hecker - Jones - Jewell Milling Co., New York City ..	*Southington:* Southington Lumber Co.	11.18	6.60	14.19	14.00	9.78	14.00	53.07	5.18	3.50

Table I. Analyses of Commercial Feeds, Inspection of 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
			Water	Ash	Protein (N x 6.25)		Fiber		Nitrogen-free extract (starch, gum, etc.)	Fat	
					Found	Guaranteed, not less than	Found	Guaranteed, not more than		Found	Guaranteed, not less than
	Wheat Products—*Continued*		%	%	%	%	%	%	%	%	%
	Wheat Bran—Concluded										
2475	*Black Hawk, Pure.* International Milling Co., Minneapolis, Minn.	*Guilford:* F. H. Rolf, Inc.	11.35	6.93	16.00	15.00	9.68	12.00	50.64	5.40	3.20
2664	*Pure.* Larabee Flour Mills, Kansas City, Mo.	*Meriden:* Raymond Ives	12.23	6.85	15.69	15.00	8.53	10.00	52.35	4.35	3.50
2445	*Winter.* Larabee Flour Mills, Kansas City, Mo.	*East Haven:* F. A. Forbes	11.90	7.07	15.06	15.00	9.82	10.00	51.80	4.35	3.50
2568	*Moon's.* Geo. Q. Moon & Co., Binghamton, N. Y.	*Stratford:* Z. C. Ingersoll	11.45	5.28	15.56	13.00	7.90	10.00	54.53	5.28	3.00
1136	*Pure.* Nebraska Consolidated Mills Co., Omaha, Neb.	*East Winsted:* Leonard Grain Co.	10.68	6.36	16.69	15.50	8.01	11.00	53.91	4.35	3.50
2834	*Niagara Choice.* Niagara Milling Co., Niagara Falls, N. Y.	*New Haven:* Moran-Paton Co.	10.25	7.03	15.63	14.00	10.46	11.00	51.28	5.35	3.50
2448	*Ogilvie's.* Ogilvie Flour Mills Co., Montreal, Canada	*Branford:* S. V. Osborn Est.	11.60	5.51	14.63	14.50	10.35	11.50	52.46	5.45	4.00
2595	*Pillsbury.* Pillsbury's Flour Mills, Minneapolis, Minn.	*Bethel:* Morrison & Dunham	11.10	6.95	15.00	14.00	10.18	12.00	51.22	5.55	4.00

2520	*Superior Pure.* Robin Hood Mills, Calgary, Canada	*Colchester:* J. Buratz	10.20	5.28	16.13	15.00	9.90	11.50	53.41	5.08	3.50
2956	*Dependable Rex.* Royal Milling Co., Great Falls, Montana	*Danielson:* Young Bros. Co.	11.20	5.07	16.81	15.00	8.53	10.00	53.21	5.18	4.00
2777	*Occident.* Russell-Miller Milling Co., Minneapolis, Minn.	*Granby:* R. L. Forsyth	9.83	6.29	15.56	14.00	10.30	11.50	52.44	5.58	4.00
2883	St. Lawrence Flour Mills, Montreal, Canada	*Shelton:* Wolf Savitsky	11.08	5.73	15.13	14.50	10.45	11.50	51.73	5.88	4.00
	Wheat Middlings, etc.										
1003	*Rex.* Chas. M. Cox, Boston, Mass.	*Hamden:* Ira W. Beers	9.40	3.77	17.25	16.00	6.30	7.50	57.33	5.95	5.00
2587	*Wheat Shorts.* Dominion Flour Mills, Montreal, Canada	*West Cheshire:* Cheshire Grain & Coal Co.	10.28	4.00	16.88	16.00	6.28	8.00	57.08	5.48	5.00
1085	*Eshelman's.* John W. Eshelman & Sons, Lancaster, Pa.	*Devon:* Devon Coal & Ice Co.	10.38	2.96	16.00	16.00	4.13	6.00	62.28	4.25	4.00
2811	*Washburn's Gold Medal.* General Mills, Inc., Minneapolis, Minn.	*Willimantic:* Willimantic Grain Co.	10.73	3.72	17.81	16.00	3.68	6.00	59.26	4.80	4.00
2476	*Washburn's Gold Medal.* General Mills, Inc., Minneapolis, Minn.	*Guilford:* F. H. Rolf, Inc.	10.75	4.77	16.13	15.00	7.75	9.50	54.22	6.38	4.00
2588	H. Hecker-Jones-Jewell Milling Co., New York City	*Plantsville:* Atwater Mills	9.85	5.13	16.94	15.00	7.53	9.50	55.02	5.53	5.00
2741	*Black Hawk Wheat Flour.* International Milling Co., Minneapolis, Minn.	*Suffield:* Spencer Bros.	10.20	2.60	17.50	16.00	2.40	4.00	63.57	3.73	3.50
2478	*Black Hawk Wheat Standard.* International Milling Co., Minneapolis, Minn.	*Guilford:* Fred C. Morse & Son	10.73	4.81	16.75	16.00	6.83	8.50	55.03	5.85	4.50
2845	*Red Star Flour.* E. Manchester & Sons, Winsted	*East Winsted:* Leonard Grain Co.	10.83	2.86	17.25	15.00	3.65	6.00	60.98	4.43	4.00
2850	*Bull Brand Wheat Flour.* Maritime Milling Co., Buffalo, N. Y.	*Brookfield:* S. A. Smith & Son	10.55	3.18	15.00	15.00	5.35	6.00	61.67	4.25	4.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein: Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	WHEAT PRODUCTS—*Continued*										
	Wheat Middlings, etc.—Concl.		%	%	%	%	%	%	%	%	%
2831	*Moon's Fresh Ground White.* Geo. Q. Moon & Co., Binghamton, N. Y.	*Higganum:* Felix Petrofsky	10.28	4.68	16.13	15.00	6.82	7.50	57.46	4.63	3.50
2746	*Niagara Choice.* Niagara Falls Milling Co., Niagara Falls, N. Y.	*Waterbury:* Spencer Grain Co.	9.48	5.13	17.31	15.50	7.73	9.50	54.67	5.68	4.00
2695	*Wheat Flour.* Northwestern Consolidated Milling Co., Minneapolis, Minn.	*Farmington:* Winchell Smith Grist Mill	9.90	3.68	17.88	15.00	5.38	6.00	57.96	5.20	4.00
2819	*Ogilvie's Wheat Shorts.* Ogilvie Flour Mills Co., Winnepeg, Canada	*Danielson:* Young Bros. Co.	10.38	3.82	16.75	16.00	6.60	8.00	57.50	4.95	5.00
2529	*Flour.* Park & Pollard Co., Buffalo, N. Y.	*Lebanon:* Berkman Grain Co.	10.68	3.98	16.25	16.00	5.08	6.00	59.51	4.50	4.00
2859	*Pillsbury's Hard Wheat A.* Pillsbury Flour Mills Co., Minneapolis, Minn.	*Canaan:* Ives & Pierce	10.55	3.40	17.63	16.00	4.28	6.00	59.31	4.83	4.00

2686	*Pillsbury's Hard Wheat Standard B.* Pillsbury Flour Mills Co., Minneapolis, Minn.	*Kensington:* S. F. Labieniec	10.50	5.08	15.88	15.00	8.55	9.50	54.86	5.13	4.00
2517	*Superior Pure Wheat Shorts.* Robin Hood Mills, Calgary, Canada	*Norwich:* A. E. Shedd	10.38	3.38	16.75	17.00	5.98	8.00	58.76	4.75	5.00
2756	*Shorts.* Standard Milling Co., Toronto, Canada	*Thomaston:* Thomaston Grain & Coal Co.	10.10	4.98	18.13	16.00	7.25	8.00	53.86	5.68	5.00
2575	*Wirthmore Flour.* St. Albans Grain Co., St. Albans, Vt.	*Shelton:* Shelton Feed Co.	10.50	4.13	16.31	15.00	5.75	6.00	58.88	4.43	4.00
2779	*Syragold Flour.* Syracuse Milling Co., Syracuse, N. Y.	*Granby:* E. H. Rollins	10.10	4.03	16.75	15.00	6.00	6.00	58.32	4.80	4.00
2488	*Big (Y) Flour.* Yantic Grain & Products Co., Norwich, Conn.	*Jewett City:* Big Y Feed Store	10.55	3.86	16.63	17.00	5.50	5.00	58.71	4.75	5.00
	Wheat Red Dog										
1090 •	*Washburn's Gold Medal Adrian.* General Mills, Inc., Minneapolis, Minn.	*Norwalk:* Frank Libner & Sons	10.83	2.39	16.31	16.00	2.07	4.00	64.42	3.98	3.50
2535	Hecker-Jones-Jewell Milling Co., Buffalo, N. Y.	*Colchester:* L. Broder	10.30	2.83	17.00	15.00	2.95	3.75	62.29	4.63	4.25
2904	Hecker-Jones-Jewell Milling Co., New York City	*Norwalk:* Frank Libner & Sons	10.00	3.36	17.25	15.75	3.73	4.00	59.96	5.70	4.50
	Wheat Feed (Mixed Feed)										
2860	*Crosby's.* Crosby Milling Co., Brattleboro, Vt.	*Kent:* Kent Grain & Coal Co.	11.03	4.41	14.94	15.00	6.78	9.50	57.99	4.85	4.50
2797	*Boston.* Duluth Superior Milling Co., Duluth, Minn.	*Hartford:* N. Y. Feed & Grain Co.	10.93	4.81	15.75	14.00	7.33	9.50	55.78	5.40	4.00
2571	*Washburn's Gold Medal Fancy.* General Mills, Inc., Minneapolis, Minn.	*Derby:* Peterson-Hendee Co.	12.40	4.70	15.38	15.00	5.48	7.50	58.01	4.03	4.00
2708	*Gold Mine.* H. H. King Flour Mills, Minneapolis, Minn.	*Thompsonville:* Geo. S. Phelps & Co.	10.60	5.20	19.31	15.00	8.85	9.50	50.46	5.58	4.50
1139	*Red Star.* E. Manchester & Sons, Winsted	*Winsted:* E. Manchester & Sons	10.65	5.33	15.50	16.00	7.44	7.50	56.60	4.48	4.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein: Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	WHEAT PRODUCTS—*Continued* *Wheat Feed (Mixed Feed)—Concluded*		%	%	%	%	%	%	%	%	%
2062	*Red Wing.* Meech & Stoddard, Inc., Middletown	*East Hartford:* Meech Grain Co.	10.35	3.93	16.13	15.00	6.90	10.00	57.84	4.85	4.50
1047	*Osoto.* National Milling Co., Toledo, Ohio	*Bloomfield:* Bloomfield Farmers' Exchange	10.15	5.67	16.50	15.00	7.13	10.00	56.07	4.48	4.50
2693	*Planet.* Northwestern Consolidated Milling Co., Minneapolis, Minn.	*Farmington:* Winchell Smith Grist Mill	10.93	4.58	18.00	15.00	5.38	8.00	56.36	4.75	4.00
1048	*XXX Comet.* Northwestern Consolidated Milling Co., Minneapolis, Minn.	*Bloomfield:* Bloomfield Farmers' Exchange	10.20	2.93	18.38	16.00	2.10	4.00	60.61	5.78	4.00
2684	*Pillsbury's Fancy Mixed.* Pillsbury Flour Mills, Minneapolis, Minn.	*Kensington:* S. F. Labieniec	10.93	4.48	17.69	15.00	5.40	8.50	56.42	5.08	4.00
2447	*Pillsbury's XX Daisy.* Pillsbury Flour Mills, Minneapolis, Minn.	*East Haven:* F. A. Forbes	11.73	2.66	17.06	16.00	2.19	4.00	61.98	4.38	4.00
2649	*Occident.* Russell Miller Milling Co., Minneapolis, Minn.	*Wallingford:* A. E. Hall	11.33	4.83	17.00	15.00	7.78	9.50	53.18	5.88	4.50

2451	*Wirthmore.* St. Albans Grain Co., St. Albans, Vt.	*Branford:* S. V. Osborn Est.	12.00	4.31	14.81	15.00	8.05	8.00	55.55	5.28	4.50
2489	*Big Y Mixed.* Yantic Grain & Products Co., Norwich	*Norwich:* Yantic Grain & Products Co.	10.28	5.45	16.88	16.00	6.88	8.00	55.68	4.83	4.50
	MAIZE PRODUCTS										
	Corn Gluten Feed, etc.										
968	*Clinton Gluten Feed.* Clinton Corn Syrup Refining Co., Clinton, Iowa	*Guilford:* F. H. Rolf, Inc.	9.20	7.38	22.00	23.00	8.25	8.50	49.12	4.05	2.00
2635	*Clinton Gluten Feed.* Clinton Corn Syrup Refining Co., Clinton, Iowa	*Seymour:* Seymour Grain & Coal Co.	8.20	5.88	23.31	23.00	8.13	8.50	51.15	3.33	2.00
1146	*Buffalo Gluten Feed.* Corn Products Refining Co., New York City	*Farmington:* Winchell Smith Grist Mill	10.33	8.09	23.31	23.00	8.58	8.50	48.04	1.65	2.00
2454	*Buffalo Gluten Feed.* Corn Products Refining Co., New York City	*Branford:* S. V. Osborn Est.	9.00	6.98	23.75	23.00	7.32	8.50	50.70	2.25	2.00
2525	*Diamond Gluten Meal.* Corn Products Refining Co., New York City	*Norwich:* Yantic Grain & Products Co.	7.65	1.70	41.25	40.00	3.43	4.00	43.74	2.23	1.00
2477	*Staley's Gluten Feed.* A. E. Staley Mfg. Co., Decatur, Ill.	*Guilford:* Fred C. Morse & Son	10.08	6.30	28.13	23.00	5.75	8.00	48.11	1.63	1.00
2573	*Union Gluten Feed.* Union Sales Corp., Columbus, Ind.	*Derby:* Peterson-Hendee Co.	10.15	7.63	26.31	23.00	7.25	8.00	46.03	2.63	1.00
	Hominy Feed, etc.										
2619	*Amco Corn Feed Meal.* American Milling Co., Peoria, Ill.	*Danbury:* C. S. Barnum & Son	11.75	2.10	9.88	9.00	3.08	5.00	68.24	4.95	4.00
2685	*Emco.* Evans Milling Co., Indianapolis, Ind.	*Kensington:* S. F. Labieniec	10.25	2.45	10.06	10.00	3.78	5.50	67.03	6.43	6.00
2697	*White.* Kellogg Co., Battle Creek, Mich.	*Collinsville:* Lawton-Miner Co.	9.18	2.35	10.25	10.00	3.85	5.00	67.54	6.83	6.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein: Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	MAIZE PRODUCTS—*Concluded* *Hominy Feed, etc.—Concluded*		%	%	%	%	%	%	%	%	%
• 1131	*Badger White.* Chas. A. Krause Milling Co., Milwaukee, Wis.	*Torrington:* Litchfield Co-op. Assoc.	8.95	2.85	11.06	10.00	5.07	5.00	64.92	7.15	6.00
2650	*Steam Cooked.* Miner-Hillard Milling Co., Wilkes-Barre, Pa.	*Wallingford:* A. E. Hall	10.85	2.15	10.44	10.00	3.38	5.00	68.70	4.48	4.00
2837	*Moon's.* Geo. Q. Moon & Co., Binghamton, N. Y.	*Torrington:* F. W. Wadhams	10.15	2.13	10.13	10.00	5.58	6.00	66.63	5.38	5.00
2792	*Poco.* Mt. Vernon Milling Co., Mt. Vernon, Ind.	*Windsor:* L. W. Hudson	9.08	3.00	11.31	10.00	5.15	6.00	63.81	7.65	7.00
2788	Patent Cereal Co., Geneva, N. Y.	*Bloomfield:* Bloomfield Farmers' Exchange	10.90	2.66	10.50	10.00	5.08	5.00	65.43	5.43	5.00
2480	*Burt's.* Postum Company, Inc., Battle Creek, Mich.	*Lyme:* Lyme Grain Co.	10.28	2.74	10.63	10.00	4.67	5.00	64.55	7.13	6.00
1158	*Pratt's White.* Pratt Food Co., Buffalo, N. Y.	*Norwalk:* Frank Libner & Sons	11.05	2.06	9.50	10.00	3.08	6.00	69.38	4.93	4.00

2498	Quaker Oats Co., Chicago, Ill...	*New London:* New London Grain Co.	10.45	2.97	10.75	10.00	5.30	8.00	64.78	5.75	5.00
2522	*White.* Quaker Oats Co., Chicago, Ill.	*Colchester:* J. Buratz	9.50	2.13	10.00	10.50	4.78	6.00	67.89	5.70	5.00
2584	*Yellow.* Quaker Oats Co., Chicago, Ill.	*Ansonia:* I. Sovitsky Grain & Coal Co.	10.40	2.65	10.25	10.50	4.10	6.00	67.17	5.43	5.00
2868	*Corn Feed Meal.* Ralston Purina Co., St. Louis, Mo.	*Danbury:* H. E. Meeker	11.40	1.53	8.88	8.50	3.50	5.00	71.06	3.63	3.00
2443	*Paragon.* St. Albans Grain Co., St. Albans, Vt.	*East Haven:* F. A. Forbes	11.10	4.02	9.88	10.00	5.04	7.00	62.16	7.80	6.00
	Rye Products										
2765	*Rye Middlings.* Miner-Hillard Milling Co., Wilkes-Barre, Pa.	*Higganum:* Felix Petrofsky	9.73	3.08	16.19	12.00	2.68	5.00	65.39	2.93	2.50
2928 •	*Rye Feed.* Upper Hudson Rye Flour Mills, Troy, N. Y.	*Middletown:* Meech & Stoddard, Inc.	9.95	3.60	17.13	13.50	5.03	6.00	60.76	3 53	3.00
	Brewers' and Distillers' Grains										
2710	*"Bull Brand" Dried Brewers' Grains.* Farmers Feed Co., Buffalo, N. Y.	*Thompsonville:* Geo. S. Phelps & Co.	7.25	3.83	22.88	22.00	15.30	15.00	43.46	7.28	6.00
2634	*Alco Dried Brewers' Grains.* C. J. Martenis Grain Co, New York City	*Seymour:* Seymour Grain & Coal Co.	7.73	4.20	23.56	21.00	14.15	20.00	43.53	6.83	6.00
1091	*Alco Dried Distillers' Grains.* C. J. Martenis Grain Co, New York City	*Seymour:* Seymour Grain & Coal Co.	5.98	2.38	21.69	25.00	12.00	15.00	47.82	10.13	8.00
1118	*Brewers' Dried Grains.* St. Albans Grain Co., St. Albans, Vt.	*New Milford:* Geo. T. Soule	7.03	3.32	20.69	21.00	12.55	15.00	49.98	6 43	5.00
	Dried Beet Pulp										
2444	The Larrowe Milling Co., Detroit, Mich.	*East Haven:* F. A. Forbes	11.50	3.70	7.94	8.00	19.01	22.00	56.90	0.95	0.50

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
					Protein (N x 6.25)		Fiber			Fat	
			Water	Ash	Found	Guaranteed, not less than	Found	Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Found	Guaranteed, not less than
	DRIED BEET PULP—*Concluded*		%	%	%	%	%	%	%	%	%
963	*Dried Molasses Beet Pulp.* Larrowe Milling Co., Detroit, Mich.	*Wallingford:* A. E. Hall	9.05	4.99	10.00	8.00	18.28	20.00	56.93	0.75	0.50
2711	*Dried Beet Pulp.* Milmine Bodman & Co., Inc., New York City	*Thompsonville:* Geo. S. Phelps & Co.	9.28	3.25	8.25	7.00	17.70	20.00	60.97	0.55	0.25
	PROPRIETARY MIXED FEEDS *Horse Feed*										
2605	*Amco.* American Milling Co., Peoria, Ill.	*Danbury:* C. S. Barnum & Son	10.80	2.83	10.25	9.00	6.28	9.00	66.59	3.25	3.50
2618	*Amco June Pasture Alfalfa and Molasses.* American Milling Co., Peoria, Ill.	*Danbury:* C. S. Barnum & Son	8.15	10.48	12.13	10.00	16.50	21.00	51.94	0.80	0.50
2665	*Wonder Horse and Mule.* Arcady Farms Milling Co., Chicago, Ill.	*Meriden:* Raymond Ives	12.98	4.08	9.81	9.00	7.80	10.00	62.00	3.33	3.00

2739	*Wonder Sweet Lasses.* Arcady Farms Milling Co., Chicago, Ill.	*New Britain:* S. P. Strople	9.08	9.48	11.88	9.00	16.35	25.00	51.88	1.33	1.00
2749	*Beacon Hog Feed.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Bethlehem:* A. T. Minor	9.30	8.73	19.38	18.00	6.20	7.00	50.89	5.50	5.00
2604	*Beacon.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Danbury:* C. S. Barnum & Son	12.33	3.68	10.50	9.00	5.53	11.00	65.46	2.50	2.50
2865	*Be-Co-Las.* Beacon Milling Co., Inc., Cayuga, N. Y.	*New Milford:* W. L. Richmond	11.05	7.11	13.31	11.00	13.35	12.00	53.65	1.53	1.00
2994	*Chariot.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Shelton:* Shelton Feed Co., Inc.	9.25	4.50	10.81	8.00	7.13	10.00	65.73	2.58	2.00
2505	*Extra Vim Molasses.* C. W. Campbell Co., Westerly, R. I.	*Groton:* C. W. Campbell Co.	11.33	4.60	10.00	10.00	10.15	12.00	60.19	3.73	2.00
2506	*Provender.* C. W. Campbell Co., Westerly, R. I.	*Groton:* C. W. Campbell Co.	11.08	2.43	10.63	10.00	5.63	10.00	67.10	3.13	4.00
2979	*Provender.* C. W. Campbell Co., Westerly, R. I.	*Groton:* C. W. Campbell Co.	11.10	2.78	10.50	10.00	6.05	10.00	64.57	5.00	4.00
2624	*Ajax.* Chapin & Co., Hammond, Ind.	*Danbury:* F. C. Benjamin	10.78	5.90	10.94	9.00	9.10	12.00	60.10	3.18	3.00
2626	*Davis.* R. G. Davis & Sons, New Haven	*Westville:* R. G. Davis & Sons.	10.85	3.35	8.38	9.00	7.18	10.00	66.66	3.58	3.00
2832	*Davis No. 1 Provender.* R. G. Davis & Sons, New Haven	*New Haven:* R. G. Davis & Sons	10.85	2.37	10.06	10.00	5.41	8.00	66.01	5.30	3.50
2621	*Alfalfa Meal.* Denver Alfalfa Milling & Products Co., Lamar, Colorado	*Danbury:* C. S. Barnum & Son	8.58	8.23	11.44	13.00	33.28	33.00	37.04	1.43	1.00
6817	*Alfalfa Leaf Meal (Leafalfa Brand).* Denver Alfalfa Milling & Products Co., Lamar, Colorado	*Putnam:* Dayville Grain Co.	8.28	14.16	21.13	20.00	14.78	18.00	39.07	2.58	2.50
2487	*Eastern States Open Formula.* Eastern States Farmers' Exchange, Springfield, Mass.	*Norwich:* A. E. Shedd	11.45	3.41	11.38	10.50	5.78	6.50	63.75	4.23	3.50

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein: Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Horse Feed—Continued		%	%	%	%	%	%	%	%	%
645	*Elmore, with Molasses.* Elmore Milling Co., Oneonta, N. Y. ..	*Hazardville:* A. D. Bridge's Sons	12.13	4.15	10.25	9.00	6.60	11.00	63.37	3.50	2.50
902	*Eshelman's Lancaster 60.* John W. Eshelman & Sons, Lancaster, Pa.	*Norwalk:* Frank Libner & Sons	11.23	4.82	10.00	9.00	9.98	10.00	60.57	3.40	2.50
896	*Liberty.* John W. Eshelman & Sons, Lancaster, Pa.	*Southport:* C. Buckingham & Co.	8.30	6.71	9.00	7.00	11.88	10.00	61.53	2.58	2.00
567	*Eshelman's Red Rose 85.* John W. Eshelman & Sons, Lancaster, Pa.	*Stratford:* Farmers' Flour & Grain Co.	10.78	3.00	9.50	9.00	7.10	10.00	65.69	3.93	3.00
991	*Eshelman's Thorobred.* John W. Eshelman & Sons, Lancaster, Pa.	*New Britain:* Wm. Cohen	7.05	1.88	10.13	9.00	4.38	6.00	72.33	4.23	4.00
706	*Imperial Steamed Cooked.* Imperial Grain & Milling Co., Toledo, Ohio	*Hazardville:* A. D. Bridge's Sons	10.00	2.13	10.13	9.50	4.78	4.60	68.43	4.53	4.00

2849	*Bull Brand, with Molasses.* Maritime Milling Co., Buffalo, N. Y.	*Brookfield:* S. A. Smith & Son	11.50	3.23	9.50	8.00	7.93	10.00	63.89	3.95	2.00
2554	*Red Wing Molasses.* Meech & Stoddard, Inc., Middletown ..	*Colchester:* Red Wing Feed & Lumber Co.	10.85	3.63	10.75	9.00	7.58	10.00	63.16	4.03	3.00
2514	*"1795" Steamed Cooked Corn & Oats.* Miner-Hillard Milling Co., Wilkes-Barre, Pa.	*Westerly:* C. W. Campbell Co..	8.75	2.18	9.75	9.50	5.15	5.00	69.84	4.33	4.00
969	*Old Mill.* Fred C. Morse & Son, Guilford	*Guilford:* Fred C. Morse & Son	11.33	3.89	11.75	12.00	5.75	9.00	63.23	4.05	4.00
1035	*Old Mill Provender..* Fred C. Morse & Son, Guilford	*Guilford:* Fred C. Morse & Son	12.58	2.14	10.00	10.00	4.75	7.00	67.15	3.38	4.00
2780	*Domino Vim-O-Lene.* Nowak Milling Corp., Hammond, Ind.	*Bloomfield:* Bloomfield Farmers' Exchange	11.20	3.34	9.25	9.50	5.85	9.00	66.91	3.45	3.00
2836	*Big Value Molasses.* Ontario Milling Co., Oswego, N. Y. ..	*Collinsville:* Rourke-Robotham Co.	11.60	5.65	11.25	8.50	10.86	12.00	58 36	2.28	2.00
2450	*Osborn's Provender.* S. V. Osborn Est., Branford	*Branford:* S. V. Osborn Est. ..	12.83	2.28	10.13	10.00	5.72	8.00	65.06	3.98	4.00
2910	*Belmont.* Park & Pollard Co., Buffalo, N Y.	*Greenwich:* T. Loughlin & Son	9.03	3.87	9.94	10.00	7.75	12.00	65.33	4.08	2.00
1069	*Corn & Oats ½ & ½.* Park & Pollard Co., Buffalo, N. Y. ..	*Shelton:* Shelton Feed Co.	11.85	2.50	9.88	10.00	7.95	8.00	63.92	3.90	1.50
2648	*Chelsea.* Park & Pollard Co., Buffalo, N. Y.	*Naugatuck:* Spencer Grain Co..	9.30	6.80	9.06	8.00	14.38	12.00	58 00	2.55	2.00
2572	*Park & Pollard.* Park & Pollard Co., Buffalo, N. Y.	*Derby:* Peterson-Hendee Co. ...	11.45	3.58	10.38	10.00	6.50	9.00	64.59	3.50	3.50
2616	*Velvet Meal.* Pecos Valley Alfalfa Milling Co., Hagerman, New Mexico	*Guilford:* F. H. Rolf, Inc.	9.48	11.15	17.13	17.00	20.73	23.00	39.41	2.10	1.50
2691	*Pratt's Utility.* Pratt Food Co., Hammond, Ind.	*Bristol:* Bristol Grain & Supply Co.	12.18	4.20	8.50	6.50	8.35	12.00	64.02	2.75	1.50
2630	*Banner Feed.* Quaker Oats Co., Chicago, Ill.	*Seymour:* Seymour Grain & Coal Co.	7.70	5.80	14.13	13.00	16.90	18.00	49.94	5.53	4.50
2492	*Horse Power Feed.* Quaker Oats Co., Chicago, Ill.	*Chester:* Leete Bros.	11.60	5.15	11.56	10.00	9.05	11.00	59.89	2.75	2.80

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein (N x 6.25): Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	PROPRIETARY *MIXED* FEEDS—*Continued*										
	Horse Feeds—Concluded		%	%	%	%	%	%	%	%	%
2594	*Quaker Green Cross.* Quaker Oats Co., Chicago, Ill.	*Bethel:* Morrison & Dunham	11.55	5.78	10.13	10.00	11.25	12.00	58.36	2.93	2.50
1052	*Sugared Vim Feed.* Quaker Oats Chicago, Ill.	*Branford:* S. V. Osborn Est.	6.60	6.63	6.25	5.00	23.95	25.00	54.44	2.13	1.50
2655	*Buffalo Purina Bulky Las.* Ralston Purina Co., St. Louis, Mo.	*Meriden:* H. Grulich	9.35	8.73	11.25	9.00	14.15	15.00	54.32	2.20	1.30
1109	*Purina Checkerboard Rolled Oats (steam cooked).* Ralston Purina Co., St. Louis, Mo.	*Stamford:* Clapboard Hill Feed Co.	8.00	1.94	15.88	16.00	1.07	2.00	67.21	5.90	6.00
2513	*Purina Omoline Feed.* Ralston Purina Co., St. Louis, Mo.	*Westerly:* C. W. Campbell Co.	11.30	3.93	10.25	9.70	7.73	9.00	62.16	4.63	3.20
2433	*Diamond.* Rockville Grain & Coal Co., Rockville	*Manchester:* Manchester Grain Co.	11.83	3.29	10.00	9.00	7.38	10.00	63.27	4.23	3.00
2647	*Charlestock.* St. Albans Grain Co., St. Albans, Vt.	*Thompsonville:* Geo. S. Phelps & Co.	9.23	7.43	9.75	9.00	10.88	14.00	57.68	5.03	4.00

2784	*King.* St. Albans Grain Co., St. Albans, Vt.	*Willimantic:* Willimantic Grain Co.	10.93	2.73	9.69	9.50	6.78	9.00	65.94	3.93	3.00
2493	*Wirthmore.* St. Albans Grain Co., St. Albans, Vt.	*Centerbrook:* W. J. Prann	12.20	3.90	9.75	9.80	5.83	9.00	64.54	3.78	3.25
2889	*Syragold, with Molasses.* Syracuse Milling Co., Syracuse, N. Y.	*East Bridgeport:* J. Simon	8.55	3.68	8.69	8.00	10.83	12.00	65.80	2.45	2.50
1010	*Colonel's Ration.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Guilford:* F. H. Rolf, Inc.	11.70	6.75	14.00	12.00	11.60	15.00	52.82	3.13	2.50
2851	*Derby Corn & Oat Feed.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Hawleyville:* W. A. Honan, Inc.	11.30	2.40	10.38	9.20	5.78	8.00	65.61	4.53	4.00
2843	*Derby Meal.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Torrington:* Litchfield Co-op. Assoc.	12.00	1.55	9.56	9.02	2.46	3.50	70.25	4.18	3.06
2676	*Neverfail.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Plainville:* W. S. Eaton	12.35	3.40	10.06	10.00	5.43	9.00	64.86	3.90	3.50
2533	*Crusader.* Ubiko Milling Co., Cincinnati, Ohio	*Lebanon:* Berkman Grain Co.	12.05	6.49	10.69	9.00	8.98	10.00	58.36	3.43	3.00
856	*Wayne Supreme.* Wayne Feed Mills, Fort Wayne, Ind.	*New Britain:* New Britain Bird Store	8.68	2.95	9.88	9.50	6.53	7.00	68.11	3.85	3.50
2888	*Wertz's Horse Feed with Alfalfa and Molasses.* F. S. Wertz & Son., Reading, Pa.	*Long Hill:* Long Hill Feed Store	9.90	4.43	9.69	9.00	9.20	10.00	62.55	4.23	2.00
1276	*Al-Mo.* Yantic Grain & Products Co., Norwich	*New London:* New London Grain Co.	11.93	9.12	12.25	11.00	12.97	15.00	52.03	1.70	1.50
2877	*Big (Y) Horse Feed.* Yantic Grain & Products Co., Norwich	*New London:* New London Grain Co.	11.30	4.28	11.50	10.00	6.18	7.00	63.24	3.50	3.00
	Dairy Feeds										
2563	*Amco 20% (Flexible Formula).* American Milling Co., Peoria, Ill.	*Danbury:* C. S. Barnum & Son	9.65	8.23	21.19	20.00	7.78	9.00	49.55	3.60	4.00

Table I. Analyses of Commercial Feeds, Inspection of 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein: Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	Proprietary Mixed Feeds—*Continued*										
	Dairy Feeds—Continued		%	%	%	%	%	%	%	%	%
2620	*Amco 24% (Flexible Formula).* American Milling Co., Peoria, Ill.	*Danbury:* C. S. Barnum & Son	9.03	7.86	25.13	24.00	7.65	9.00	46.05	4.28	4.00
2666	*Advanced Registry.* Arcady Farms Milling Co., Chicago, Ill.	*Meriden:* Raymond Ives	8.95	8.23	24.38	25.00	8.88	10.00	45.03	4.53	5.00
2988	*Advanced Registry.* Arcady Farms Milling Co., Chicago, Ill.	*New Britain:* S. P. Strople	8.50	7.48	25.38	25.00	9.03	10.00	44.71	4.90	5.00
2524	*Milkers Ready Ration.* Arcady Farms Milling Co., Chicago, Ill.	*Norwich:* A. E. Shedd	9.60	9.39	21.25	22.00	9.80	11.00	44.98	4.98	4.00
2737	*Old Colony Feed.* Arcady Farms Milling Co., Chicago., Ill	*Meriden:* Raymond Ives	8.48	9.53	20.50	20.00	8.55	12.00	48.79	4.15	3.50
2821	*Peerless Milk Ration.* Arcady Farms Milling Co., Chicago, Ill.	*Danielson:* Kennedy Corp.	8.90	9.48	20.69	20.00	11.83	12.00	44.65	4.45	4.00
2820.	*Sweet 16.* Arcady Farms Milling Co., Chicago, Ill.	*Danielson:* Kennedy Corp.	10.20	8.91	17.19	16.00	12.58	12.00	46.99	4.13	4.00
2678	*Wonder.* Arcady Farms Milling Co., Chicago, Ill.	*New Britain:* S. P. Strople	10.28	8.18	23.19	24.00	9.75	10.00	44.02	4.58	5.20

2981	*Wonder.* Arcady Farms Milling Co., Chicago, Ill.	*Norwich:* A. E. Shedd	9.85	9.27	25.00	24.00	8.30	10.00	43.10	4.48	5.20
2977	*Capital Dairy Feed, Sweetened.* E. W. Bailey & Co., Montpelier, Vt.	*New London:* B. J. McCarthy	10.20	8.03	22.38	24.00	7.43	9.00	47.66	4.30	5.00
2701	*Favorite Dairy Ration, Sweetened.* E. W. Bailey & Co., Montpelier, Vt.	*Lebanon:* Berkman Grain Co.	10.23	7.35	19.81	20.00	6.90	7.50	51.78	3.93	4.50
2810	*"Our Own."* E. W. Bailey & Co., Montpelier, Vt.	*Mansfield Depot:* M. M. Hansen	10.10	8.04	18.31	16.00	8.18	9.00	50.54	4.83	5.00
2574	*Auburn.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Shelton:* Shelton Feed Co.	9.13	8.50	23.00	20.00	8.15	10.00	46.87	4.35	4.00
2603	*Beacon.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Danbury:* C. S. Barnum & Son	8.93	8.10	24.50	24.00	8.88	10.00	44.76	4.83	4.50
2617	*Beacon Sweet "24."* Beacon Milling Co., Inc., Cayuga, N. Y.	*Danbury:* C. S. Barnum & Son	9.33	7.13	25.25	24.00	8.08	9.00	46.91	3.30	4.00
•2705	*Success.* A. D. Bridge's Sons, Hazardville	*Hazardville:* A. D. Bridge's Sons	8.88	5.68	21.13	20.00	11.00	9.50	48.61	4.70	5.00
2534	*L. B. Milk Ration.* L. Broder, Colchester	*Colchester:* L. Broder	9.50	7.78	19.63	20.00	7.38	8.50	50.41	5.30	5.50
1248	*C. B.* C. Buckingham & Co., Southport	*Southport:* C. Buckingham & Co.	10.10	7.94	23.63	22.75	8.93	9.50	44.90	4.50	4.50
2507	*No-Botheration.* C. W. Campbell Co., Westerly, R. I.	*Mystic:* C. W. Campbell	10.30	6.59	19.63	20.00	6.43	8.00	52.05	5.00	5.00
2631	*Ajax 20%.* Chapin & Co., Hammond, Ind.	*Plantsville:* C. A. Cowles	10.43	9.23	20.00	20.00	7.83	12.00	47.88	4.63	4.50
2622	*Ajax 24%.* Chapin & Co., Hammond, Ind.	*Danbury:* F. C. Benjamin	10.23	8.75	24.00	24.00	8.83	12.00	43.56	4.63	4.50
2625	*Unicorn.* Chapin & Co., Hammond, Ind.	*Danbury:* F. C. Benjamin	8.98	9.80	24.94	24.00	9.03	10.00	42.75	4.50	5.00
2922	*Grange Sweetened 16%.* Clyde Renco Milling Corp., Clyde, N. Y.	*Canaan:* Ives & Pierce	11.03	8.10	18.00	16.00	6.15	12.00	52.52	4.20	4.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein: Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Dairy Feeds—Continued		%	%	%	%	%	%	%	%	%
2921	*Renco Farmers' Special Sweetened Feed.* Clyde Renco Milling Corp., Clyde, N. Y.	*Canaan:* Ives & Pierce	10.33	7.63	22.38	20.00	8.38	9.00	46.78	4.50	3.50
2923	*Renco Makempay Sweetened Feed.* Clyde Renco Milling Corp., Clyde, N. Y.	*Canaan:* Ives & Pierce	9.65	8.63	25.63	24.00	8.28	9.00	42.93	4.88	4.00
2770	*Fortune 20% Molasses.* The Coles Co., Middletown	*Middletown:* The Coles Co.	10.30	7.73	19.38	20.00	7.45	9.00	50.51	4.63	4.00
2769	*Fortune 24% Molasses.* The Coles Co., Middletown	*Middletown:* The Coles Co.	9.10	7.80	23.00	24.00	7.53	9.00	47.54	5.03	4.50
2745	*Conkey's 24% Protein.* G. E. Conkey Co., Cleveland, Ohio ..	*Ansonia:* A. Hodos & Son	9.55	6.38	25.25	24.00	8.23	9.00	46.54	4.05	5.00
2744	*Conkey's Gecco 20% Protein.* G. E. Conkey Co., Cleveland, Ohio	*Ansonia:* A. Hodos & Son	8.88	8.38	20.75	20.00	8.20	9.00	49.26	4.53	4.50

2878	*Conkey's Red Seal 16%.* G. E. Conkey Co., Cleveland, Ohio ..	*Ansonia:* A. Hodos & Son	8.58	7.77	16.25	16.00	8.28	10.00	54.52	4.60	3.50
2668	*Cowles 20%.* C. A. Cowles, Plantsville	*Plantsville:* C. A. Cowles	9.63	5.90	22.00	20.00	8.90	10.00	48.49	5.08	5.00
2669	*Cowles 24%.* C. A. Cowles, Plantsville	*Plantsville:* C. A. Cowles	9.23	5.70	24.38	24.00	8.60	10.00	46.51	5.58	6.00
2986	*Cowles 24%.* C. A. Cowles, Plantsville	*Plantsville:* C. A. Cowles	8.73	6.58	23.88	24.00	8.88	10.00	46.65	5.28	6.00
1073	*Crosby's Balanced Ration.* Crosby Milling Co., Brattleboro, Vt...	*Shelton:* Wolf Savitsky	8.28	7.23	24.75	25.00	8.35	9.00	45.99	5.40	5.50
2798	*Crosby's Ready Ration.* Crosby Milling Co., Brattleboro, Vt...	*Manchester:* O. E. Bailey	9.23	6.04	20.50	20.00	7.85	8.50	61.48	4.90	5.00
2580	*Crosby's Sweetened Ready Ration.* Crosby Milling Co., Brattleboro, Vt.	*Shelton:* Wolf Savitsky	9.98	5.88	20.25	20.00	7.98	8.50	50.86	5.05	5.00
1682	*Basic.* R. G. Davis & Sons, New Haven	*Clintonville:* John Carlson	10.57	7.11	19.75	20.00	7.58	9.00	50.45	4.54	4.50
2627	*Basic.* R. G. Davis & Sons, New Haven	*Westville:* R. G. Davis & Sons..	10.20	6.53	19.75	20.00	7.90	9.00	50.92	4.70	4.50
2736	*20% Open Formula.* R. G. Davis & Sons, New Haven	*Ansonia:* Ansonia Flour & Feed Co.	9.33	6.73	20.38	20.00	6.93	8.00	51.80	4.83	4.00
2602	*Delaware.* Delaware Mills, Inc., Deposit, N. Y.	*Danbury:* C. S. Barnum & Son ..	8.80	8.68	24.13	23.00	7.70	10.00	46.01	4.68	5.00
2551	*Delco 20%.* Delaware Mills, Inc., Deposit, N. Y.	*Colchester:* Red Wing Feed & Lumber Co.	9.88	6.48	20.50	20.00	8.23	11.00	50.71	4.20	4.00
2758	*Eastern States Fulpail (Open Formula).* Eastern States Farmers' Exchange, Springfield, Mass.	*North Haven:* Ridgewood Farm	9.80	6.33	21.88	20.00	7.33	8.00	50.06	4.60	4.00
2982	*Eastern States Milkmore (Open Formula).* Eastern States Farmers' Exchange, Springfield, Mass.	*Norwich:* A. E. Shedd	9.98	6.90	25.69	24.00	7.30	8.00	45.43	4.70	4.50

Table I. Analyses of Commercial Feeds, Inspection of 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
			Water	Ash	Protein (N x 6.25)		Fiber		Nitrogen-free extract (starch, gum, etc.)	Fat	
					Found	Guaranteed, not less than	Found	Guaranteed, not more than		Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Dairy Feeds—Continued		%	%	%	%	%	%	%	%	%
2879 •	*Eastern States 16 (Open Formula)*. Eastern States Farmers' Exchange, Springfield, Mass.	*North Haven:* Ridgewood Farm	9.58	6.53	16.88	16.00	7.45	8.00	55.13	4.43	4.00
2549	*Elmore Milk Grains.* Elmore Milling Co., Inc., Oneonta, N. Y.	*Norwich:* A. E. Shedd	9.73	5.25	23.38	25.00	9.90	11.00	46.86	4.88	5.00
2980	*Elmore Milk Grains.* Elmore Milling Co., Inc., Oneonta, N. Y.	*Norwich:* A. E. Shedd	9.10	5.20	25.19	25.00	11.05	11.00	44.53	4.93	5.00
2636	*Elmore Waldorf Formula.* Elmore Milling Co., Inc., Oneonta, N. Y.	*Naugatuck:* Naugatuck Fruit & Produce Co.	10.28	9.15	19.63	20.00	8.25	10.00	48.59	4.10	4.00
2814	*Granger Open-Formula Ration.* Elmore Milling Co., Inc., Oneonta, N. Y.	*Willimantic:* Windham Grain Store	9.60	9.66	23.94	24.00	7.45	9.00	43.90	5.45	4.00

2544	*Ostego Economy Ration.* Elmore Milling Co., Inc., Oneonta, N. Y.	*Hazardville:* A. D. Bridge's Sons	10.00	6.68	19.63	20.00	8.88	11.00	50.13	4.68	4.00
2643	*Sweet Digesto.* Elmore Milling Co., Inc., Oneonta, N. Y.	*East Hartford:* Stowe & Rondeau	9.28	6.65	14.38	16.00	14.00	12.00	51.29	4.40	4.00
2591	*Eshelman's Certified 20%.* John W. Eshelman & Sons, Lancaster, Pa.	*Rockville:* Rockville Grain & Coal Co.	9.08	6.43	22.13	20.00	7.13	8.00	51.40	3.83	4.00
2590	*Eshelman's Certified 24%.* John W. Eshelman & Sons, Lancaster, Pa.	*Rockville:* Rockville Grain & Coal Co.	8.83	6.65	26.88	24.00	7.43	8.00	45.98	4.23	4.50
2564	*Eshelman's Conestoga 18.* John W. Eshelman & Sons, Lancaster, Pa.	*Devon:* Devon Coal & Ice Co.	10.95	9.25	17.63	18.00	8.65	11.00	48.04	5.48	3.50
2565 •	*Eshelman's Lancaster 20.* John W. Eshelman & Sons, Lancaster, Pa.	*Devon:* Devon Coal & Ice Co.	10.40	8.45	21.06	20.00	8.48	11.00	46.86	4.75	4.00
2906	*Eshelman's Pennsy 16.* John W. Eshelman & Sons, Lancaster, Pa.	*South Norwalk:* Roodner Feed Co.	1125.	7.19	16.44	16.00	8.63	11.00	52.99	3.50	3.00
2652	*Eshelman's Red Rose 24.* John W. Eshelman & Sons, Lancaster, Pa.	*Wallingford:* A. E. Hall	10.73	7.35	25.00	24.00	8.33	11.00	44.61	3.98	4.00
2909	*Eshelman's Susquehanna.* John W. Eshelman & Sons, Lancaster, Pa.	*Greenwich:* Johnson's Feed Store	9.03	6.33	22.06	20.00	8.83	12.00	48.27	5.48	3.00
2429	*R Own.* F. A. Forbes, East Haven	*East Haven:* F. A. Forbes	9.83	10.17	19.75	20.00	8.42	9.00	47.08	4.75	4.00
2442	*R Own.* F. A. Forbes, East Haven	*East Haven:* F. A. Forbes	11.73	6.44	20.13	20.00	9.18	9.00	49.12	3.40	4.00
2930	*R Own.* F. A. Forbes, East Haven	*East Haven:* F. A. Forbes	11.10	4.57	19.50	20.00	8.30	9.00	52.15	4.38	4.00
2880	*Cream-O-Milk.* Flory Milling Co., Bangor, Pa.	*Granby:* E. H. Rollins	8.48	9.25	19.69	20.00	11.80	12.00	46.88	3.90	4.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Water	Ash	Protein (N x 6.25) Found	Protein Guaranteed, not less than	Fiber Found	Fiber Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat Found	Fat Guaranteed, not less than
			Pounds per Hundred								
	PROPRIETARY MIXED FEEDS—*Continued*										
	Dairy Feeds—Continued		%	%	%	%	%	%	%	%	%
2881	*Record.* Flory Milling Co., Bangor, Pa.	*Granby:* E. H. Rollins	9.20	8.57	22.00	20.00	7.65	9.00	48.63	3.95	5.00
2809	*Washburn's Gold Medal Vitamin, containing Wheat Germ (Embryo).* General Mills, Inc., Minneapolis, Minn.	*Stafford Springs:* Dennis Grain Mill	9.68	7.15	20.00	20.00	6.50	8.50	51.34	5.33	5.00
2932	*Grandin's Sweetened 24%.* D. H. Grandin Milling Co., Jamestown, N. Y.	*Falls Village:* H. E. Dean	10.03	8.45	25.13	24.00	7.18	10.00	44.46	4.75	4.00
2793	*Hudson's.* L. W. Hudson, Windsor	*Windsor:* L. W. Hudson	10.00	5.17	16.75	19.00	7.35	8.00	55.48	5.25	5.75
1253	*Apex Milk Maker.* Kasco Mills, Inc., Waverly, N. Y.	*East Winsted:* Leonard Grain Co.	10.13	7.00	19.69	20.00	9.42	11.00	48.67	5.09	4.50
1252	*Beatsall Milk Grains.* Kasco Mills, Inc., Waverly, N. Y. ..	*East Winsted:* Leonard Grain Co.	10.00	7.09	22.38	22.00	8.88	10.00	46.67	4.98	4.50

2926	*Badger 16½ Sweet.* Chas. A. Krause Milling Co., Milwaukee, Wis.	*Thomaston:* I. Levy	10.48	6.88	16.13	16.50	11.73	13.00	48.98	5.80	5.00
1046	*Larro Ready Ration.* Larrowe Milling Co., Detroit, Mich.	*Collinsville:* Lawton-Miner Co.	7.95	6.84	20.50	20.00	11.40	12.00	49.01	4.30	4.00
2471	*Larro Ready Ration.* Larrowe Milling Co., Detroit, Mich.	*Norwich:* A. E. Shedd	9.50	7.61	21.31	20.00	10.55	12.00	46.88	4.15	4.00
2688	*Mill Pride.* C. W. Lines Co., New Britain	*New Britain:* C. W. Lines Co.	9.03	7.03	23.81	24.00	7.98	10.00	47.67	4.48	5.00
2963	*Common Sense.* Litchfield Co-operative Association, Torrington	*Torrington:* Litchfield Co-op. Assoc.	8.95	7.56	20.25	20.00	8.07	9.00	49.89	5.28	4.50
2886	*Square Deal.* Long Hill Feed Store, Long Hill	*Long Hill:* Long Hill Feed Store	7.68	7.78	21.88	20.00	10.35	10.00	48.28	4.03	5.00
2847	*Red Star.* E. Manchester & Sons, Winsted	*Winsted:* E. Manchester & Sons	9.05	8.10	23.00	23.00	8.03	10.00	46.97	4.85	4.00
2848	*Red Star Special.* E. Manchester & Sons, Winsted	*Winsted:* E. Manchester & Sons	9.13	8.15	20.13	20.00	7.45	9.00	50.19	4.95	4.00
2846	*Bull Brand Sweetened.* Maritime Milling Co., Buffalo, N Y.	*Riverton:* L. A. Coe	9.75	6.63	23.31	24.00	8.09	12.00	48.07	4.15	5.00
2657	*Red Wing.* Meech & Stoddard, Inc., Middletown	*Meriden:* Meriden Grain & Coal Co.	8.93	8.38	21.88	20.00	9.20	9.00	45.76	5.85	5.50
2553	*Red Wing 20%, with Brewers' Grains.* Meech & Stoddard, Inc., Middletown	*Colchester:* Red Wing Feed & Lumber Co.	8.85	7.38	20.13	20.00	10.28	12.00	47.78	5.58	5.00
2656	*Red Wing 24%, with Brewers' Grains.* Meech & Stoddard, Inc., Middletown	*Meriden:* Meriden Grain & Coal Co.	8.45	4.70	24.88	24.00	8.90	12.00	47.24	5.83	5.50
2552	*Red Wing Special.* Meech & Stoddard, Inc., Middletown	*Colchester:* Red Wing Feed & Lumber Co.	8.38	9.14	22.63	24.00	7.98	9.00	46.29	5.58	5.50
2675	*Memo.* Mennel Milling Co., Toledo, Ohio	*Plainville:* W. S. Eaton	9.75	5.25	20.00	20.00	9.33	12.00	51.34	4.33	4.50

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
			Water	Ash	Protein (N x 6.25)		Fiber		Nitrogen-free extract (starch, gum, etc.)	Fat	
					Found	Guaranteed, not less than	Found	Guaranteed, not more than		Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Dairy Feeds—Continued		%	%	%	%	%	%	%	%	%
2953	*Memo 16% Sweet, with Molasses.* Mennel Milling Co., Toledo, Ohio	*Plainville:* W. S. Eaton	10.30	5.97	15.44	16.00	8.08	12.00	56.21	4.00	3.50
2955	*Memo 22% Milk Ration.* Mennel Milling Co., Toledo, Ohio	*Putnam:* Dayville Grain Co.	9.73	6.55	19.31	22.00	7.85	10.00	53.08	3.48	3.50
3016	*Moon's 20%, with Molasses.* Geo. Q. Moon & Co., Binghamton, N. Y.	*Plainville:* F. B. Newton	8.50	9.03	19.81	20.00	9.90	11.00	47.78	4.98	4.50
2569	*Moon's 24%.* Geo. Q. Moon & Co., Binghamton, N. Y.	*Stratford:* Z. C. Ingersoll	9.55	7.04	24.00	24.00	7.85	10.00	46.46	5.10	5.00
2830	*Moon's X.* Geo. Q. Moon & Co., Binghamton, N. Y.	*Higganum:* Felix Petrofsky	9.90	9.56	15.06	16.00	12.55	16.00	48.93	4.00	4.00
971	*Old Mill 20%.* Fred C. Morse & Son, Guilford	*Guilford:* Fred C. Morse & Son	9.65	8.46	21.88	20.00	7.23	9.00	48.55	4.23	4.50
2760	*Old Mill.* Fred C. Morse & Son, Guilford	*Guilford:* Fred C. Morse & Son	10.18	7.65	23.75	24.00	7.58	9.00	45.89	4.95	5.00

2781	*Domino 24½%.* Nowak Milling Corp., Hammond, Ind.	*Bloomfield:* Bloomfield Farmers' Exchange	8.50	8.27	25.44	24.50	8.43	10.00	44.81	4.55	5.00
2835	*Big Value.* Ontario Milling Co., Inc., Oswego, N. Y.	*Collinsville:* Rourke - Robotham Co., Inc.	9.13	6.98	20.25	20.00	10.81	10.00	48.10	4.73	4.50
2773	*Big Value, with Molasses.* Ontario Milling Co., Inc., Oswego, N. Y.	*Middletown:* P. Levson & Son	10.65	6.89	21.44	20.00	7.18	10.00	48.89	4.95	4.50
2774	*Butterfat Molasses.* Ontario Milling Co., Inc., Oswego, N. Y.	*Middletown:* P. Levson & Son	10.35	6.94	24.31	24.00	7.10	10.00	45.80	5.50	5.00
2536	*Uncle John's 24% Cream Pot.* Ontario Milling Co., Inc., Oswego, N. Y.	*Colchester:* L. Broder	8.68	7.05	24.25	24.00	8.13	9.00	46.21	5.68	3.50
2528	*Bet-R-Milk 20% Ration.* Park & Pollard Co., Buffalo, N. Y.	*Lebanon:* Berkman Grain Co.	10.45	8.60	23.13	20.00	7.60	9.00	46.19	4.03	4.00
2586 •	*Claco.* Park & Pollard Co., Buffalo, N. Y.	*West Cheshire:* Cheshire Grain & Coal Co.	10.65	6.68	20.44	20.00	7.28	9.00	50.72	4.23	4.50
2985	*Claco.* Park & Pollard Co., Buffalo, N. Y.	*West Cheshire:* Cheshire Grain & Coal Co.	10.53	7.12	20.25	20.00	7.03	9.00	50.72	4.35	4.50
2558	*Milk Maid 24%, Sweetened.* Park & Pollard Co., Buffalo, N. Y	*West Cheshire:* Cheshire Grain & Coal Co.	9.85	8.75	25.56	24.00	8.15	11.00	43.24	4.45	4.50
2638	*Overall 24%.* Park & Pollard Co., Buffalo, N. Y.	*Naugatuck:* Spencer Grain Co.	8.83	8.16	24.50	24.00	8.53	9.00	45.10	4.88	4.50
2796	*Top Notch 16%.* Park & Pollard Co., Buffalo, N. Y.	*Windsor:* Farmers' Grain & Hardware Co.	10.03	7.79	16.69	16.00	11.28	12.00	50.51	3.70	3.50
2862	*Pillsbury's.* Pillsbury Flour Mills, Minneapolis, Minn.	*New Milford:* Geo. T. Soule	9.03	7.88	20.81	20.00	8.50	10.00	48.75	5.03	5.00
2901	*Pratt's Sweet 24%.* Pratt Food Co., Buffalo, N. Y.	*Norwalk:* Frank Libner & Sons	9.13	8.98	25.13	24.00	8.75	10.00	43.16	4.85	4.00
2699	*Producer.* H. C. Puffer Co., Springfield, Mass.	*Simsbury:* Woods-Chandler Co.	9.13	6.68	25.50	24.00	7.83	8.50	46.06	4.80	4.00
2698	*Sweetened Producer.* H. C. Puffer Co., Springfield, Mass.	*Simsbury:* Woods-Chandler Co.	9.35	7.13	20.63	20.00	11.30	12.50	47.11	4.48	3.50

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
			Water	Ash	Protein (N x 6.25)		Fiber		Nitrogen-free extract (starch, gum, etc.)	Fat	
					Found	Guaranteed, not less than	Found	Guaranteed, not more than		Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Dairy Feeds—Continued		%	%	%	%	%	%	%	%	%
2511	*Quaker 20% Protein.* Quaker Oats Co., Chicago, Ill.	*Westerly:* C. W. Campbell Co..	8.68	8.64	22.44	20.00	11.80	12.00	43.74	4.70	3.25
2606	*Quaker 24% Protein.* Quaker Oats Co., Chicago, Ill.	*Danbury:* C. S. Barnum & Son ..	8.55	9.03	24.00	24.00	10.75	12.00	43.37	4.30	4.00
2905	*Protena.* Ralston Purina Co., St. Louis, Mo	*New Canaan:* Clap Board Hill Feed Co.	9.95	7.63	18.00	16.50	11.33	12.00	49.86	3.23	2.30
2654	*Purina Cow Chow.* Ralston Purina Co., St. Louis, Mo.	*Meriden:* H. Grulich	9.80	7.20	24.00	24.00	11.15	12.00	43.30	4.55	3.00
2592	*Purina Orange Checker Cow Chow.* Ralston Purina Co., St. Louis, Mo.	*Rockville:* Rockville Grain & Coal Co.	10.05	7.23	17.38	16.00	9.98	12.00	51.96	3.40	3.00
2629	*See-More-Milk.* Seymour Grain & Coal Co., Seymour	*Seymour:* Seymour Grain & Coal Co.	9.78	8.20	21.25	20.00	7.93	9.00	48.16	4.68	4.50
1145	*Millstreams "Boomerang."* Winchell Smith Grist Mill, Farmington	*Farmington:* Winchell Smith Grist Mill	9.45	6.67	22.13	24.00	6.85	10.00	50.20	4.70	6.00

2696	*Millstreams "Boomerang."* Winchell Smith Grist Mill, Farmington	*Farmington:* Winchell Smith Grist Mill	9.10	6.58	24.38	24.00	6.60	10.00	48.49	4.85	6.00
2692	*Millstreams "Twenty Percent."* Winchell Smith Grist Mill, Farmington	*Farmington:* Winchell Smith Grist Mill	9.65	6.70	20.25	20.00	7.78	8.00	51.04	4.58	5.00
2581	*Ansonia.* I. Sovitsky Grain & Coal Co., Ansonia	*Ansonia:* I. Sovitsky Grain & Coal Co.	8.55	7.60	19.69	20.00	11.18	9.70	48.18	4.80	5.90
2578	*Hygrade 20 Sweetened Milk Ration.* St. Albans Grain Co., S. Albans, Vt.	*Shelton:* Wolf Savitsky	9.90	6.58	20.19	20.00	7.13	8.50	51.82	4.38	4.00
2861	*Hygrade 24 Sweetened Milk Ration.* St. Albans Grain Co., St. Albans, Vt.	*Kent:* Kent Grain & Coal Co.	9.63	9.08	23.44	24.00	7.03	9.00	47.12	3.70	4.00
2518	*King 22 Milk Ration, Sweetened* St. Albans Grain Co., St. Albans, Vt.	*Norwich:* Norwich Grain Co.	9.88	7.35	22.25	22.00	8.93	9.00	47.19	4.40	4.50
2863	*Paragon Sweetened.* St. Albans Grain Co., St. Albans, Vt.	*New Milford:* Geo. T. Soule	8.65	14.22	21.94	22.00	10.65	12.00	40.64	3.90	4.00
2639	*Wirthmore 16 Sweetened.* St. Albans Grain Co., St. Albans, Vt.	*Wallingford:* Laden Bros.	10.98	8.33	16.88	16.00	6.70	8.00	52.63	4.48	4.00
2864	*Wirthmore 20%.* St. Albans Grain Co., St. Albans, Vt.	*New Milford:* Geo. T. Soule	8.95	5.96	20.19	20.00	7.68	8.50	52.37	4.85	5.00
2556	*Wirthmore 20, Sweetened.* St. Albans Grain Co., St. Albans, Vt.	*Hamden:* Ira W. Beers	9.88	8.25	20.38	20.00	7.43	8.00	49.11	4.95	4.75
2641	*Wirthmore 25 Balanced Ration.* St. Albans Grain Co., St. Albans, Vt.	*Kensington:* S. F. Labieniec	8.83	7.95	24.50	25.00	8.68	9.00	44.54	5.50	5.00
2453	*Wirthmore 25 Balanced Ration. Sweetened.* St. Albans Grain Co., St. Albans, Vt.	*Branford:* S. V. Osborn Est.	10.10	7.11	25.38	25.00	8.40	8.50	43.91	5.10	4.75

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
					Protein (N x 6.25)		Fiber			Fat	
			Water	Ash	Found	Guaranteed, not less than	Found	Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued* *Dairy Feeds—Continued*		%	%	%	%	%	%	%	%	%
2639	*Onondaga.* Syracuse Milling Co., Syracuse, N. Y.	*Colchester:* P. Cutler, Inc.	8.40	5.60	20.75	20.00	12.90	12.00	47.22	5.13	4.00
2538	*Syragold.* Syracuse Milling Co., Syracuse, N. Y.	*Colchester:* P. Cutler, Inc.	8.80	4.98	23.94	24.00	9.55	12.00	47.90	4.83	4.50
2782	*Syragold Milk Ration.* Syracuse Milling Co., Syracuse, N. Y.	*Manchester:* Little & McKinney	9.00	5.47	20.00	20.00	9.20	12.00	51.03	5.30	4.00
1134	*Economy.* D. L. Talcott, Torrington	*Torrington:* D. L. Talcott	8.88	11.13	23.19	23.00	8.93	9.00	42.98	4.89	4.50
2754	*Thomaston.* Thomaston Supply Co., Thomaston	*Thomaston:* Thomaston Supply Co.	9.18	8.30	21.88	20.00	8.90	8.00	46.71	5.03	6.00
2677	*E-Gee.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Plainville:* W. S. Eaton	11.35	7.18	21.19	20.00	7.10	10.00	48.78	4.40	3.50
2593	*Red Brand Tioga.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Bethel:* Morrison & Dunham	9.39	7.88	24.38	24.00	7.48	10.00	45.84	5.03	4.50
1009	*White Brand Tioga.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Guilford:* F. H. Rolf, Inc.	10.00	7.32	22.00	20.00	6.98	10.00	49.10	4.60	4.00

2532	*Ubiko Union Grains 20% Sweet.* Ubiko Milling Co., Cincinnati, Ohio	*Lebanon:* Berkman Grain Co.	9.35	9.84	21.00	20.00	8.23	10.00	46.90	4.68	4.00
2815	*Ubiko Union Grains 24% Sweet.* Ubiko Milling Co., Cincinnati, Ohio	*Lebanon:* Berkman Grain Co.	9.05	9.30	24.88	24.00	8.85	10.00	43.02	4.90	5.00
2530	*Union Grains Ubiko Biles Ready Dairy Ration.* Ubiko Milling Co., Cincinnati, Ohio	*Lebanon:* Berkman Grain Co.	7.20	8.67	23.81	24.00	9.73	10.00	45.74	4.85	5.00
2829	*Advance 16%, with Molasses.* Vitality Mills, Inc., Chicago, Ill.	*Putnam:* Dayville Grain Co.	10.25	9.63	16.50	16.00	11.45	14.00	38.12	4.05	3.50
1220	*Advance 20%.* Vitality Mills, Inc., Chicago, Ill.	*New Britain:* S. P. Strople	9.88	13.09	21.13	20.00	9.15	12.00	40.55	6.20	3.50
2740	*Vitality 20%, with Molasses.* Vitality Mills, Inc., Chicago, Ill.	*Farmington:* Winchell Smith Grist Mill	9.40	10.93	20.00	20.00	9.45	12.00	46.52	3.70	3.50
2827	*Vitality 22%, with Molasses.* Vitality Mills, Inc., Chicago, Ill.	*Putnam:* Dayville Grain Co.	10.05	9.26	20.69	22.00	10.87	12.00	44.90	4.23	4.00
2828	*Vitality 24%, with Molasses.* Vitality Mills, Inc., Chicago, Ill.	*Putnam:* Dayville Grain Co.	9.15	9.34	24.31	24.00	8.28	10.00	44.44	4.48	5.00
1006	*Will Pay.* Vitality Mills, Inc., Chicago, Ill.	*Meriden:* Raymond Ives	9.73	11.33	20.50	20.00	8.80	9.00	44.46	5.18	5.00
2816	*Abington.* Yantic Grain & Products Co., Norwich	*Abington:* Abington Grain Co.	9.15	7.47	18.75	20.00	11.90	13.00	49.03	3.70	4.00
2485	*Big Y Dairy Ration.* Yantic Grain & Products Co., Norwich	*New London:* New London Grain Co.	8.90	7.10	23.44	24.00	8.18	9.00	47.43	4.95	5.00
2481	*Uncas.* Yantic Grain & Products Co., Norwich	*Lyme:* Lyme Grain Co.	9.78	6.65	21.69	20.00	7.40	9.00	49.60	4.88	5.00
1156	*Wadfeeco.* Wadsworth Feed Co., Warren, Ohio	*Shelton:* Shelton Feed Co.	10.10	10.06	23.25	24.00	7.70	9.00	44.44	4.45	5.00
1157	*Wadsworth Special Dairy Ration.* Wadsworth Feed Co., Warren, Ohio	*Shelton:* Shelton Feed Co.	9.48	6.83	21.88	20.00	12.45	12.00	44.81	4.55	5.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
					Protein (N x 6.25)		Fiber			Fat	
			Water	Ash	Found	Guaranteed, not less than	Found	Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Dairy Feeds—Concluded		%	%	%	%	%	%	%	%	%
855	*Jumbo.* Wayne Feed Mills, Fort Wayne, Ind.	*New Britain:* New Britain Bird Store	7.60	8.75	16.63	16.00	11.65	12.00	51.32	4.05	3.50
854	*Wayne 20%.* Wayne Feed Mills, Fort Wayne, Ind.	*New Britain:* New Britain Bird Store	7.80	10.48	22.75	20.00	8.25	11.00	47.09	3.63	4.00
853	*Wayne 24%.* Wayne Feed Mills, Fort Wayne, Ind.	*New Britain:* New Britain Bird Store	6.73	12.97	25.25	24.00	8.08	11.00	42.87	4.10	4.00
	Stock Feeds										
2818	*Amco 12% Fitting Ration.* American Milling Co., Peoria, Ill.	*East Woodstock:* Ralph T. Eddy	10.58	5.98	12.75	12.00	6.40	9.00	60.14	4.15	3.50
2738	*Arcady.* Arcady Farms Milling Co., Chicago, Ill.	*New Britain:* S. P. Strople	8.68	6.38	10.88	9.00	11.65	12.00	58.71	3.70	3.50
2976	*Pennant.* E. W. Bailey & Co., Montpelier, Vt.	*New London:* B. J. McCarthy	10.08	4.52	10.38	9.50	9.68	9.50	60.99	4.35	4.50
2550	*Fortune.* The Coles Co., Middletown	*Colchester:* David Shea	9.60	3.63	10.50	9.00	10.65	11.00	61.47	4.15	3.50

1072	*Crosby's.* Crosby Milling Co. Brattleboro, Vt.	*Shelton:* Wolf Savitsky	7.93	4.70	10.00	9.00	10.88	12.00	61.41	5.08	4.00
2559	*Davis.* R. G. Davis & Sons, Inc., New Haven	*Milford:* Milford Grain Co.	9.43	4.63	11.00	10.00	9.10	14.00	60.34	5.50	2.00
2671	*Delaware.* Delaware Mills, Inc., Deposit, N. Y.	*Southington:* Southington Lumber Co.	10.28	5.93	9.94	9.00	12.85	12.00	57.10	3.90	3.00
2483	*Eastern States Fitting Ration. Open Formula.* Eastern States Farmers' Exchange, Springfield, Mass.	*Clinton:* A. L. Lockwood	11.40	6.65	13.13	12.00	6.38	7.00	58.44	4.00	3.50
2516	*Elmore.* Elmore Milling Co., Oneonta, N. Y.	*Norwich:* A. E. Shedd	8.10	4.54	9.50	10.00	11.20	12.00	62.23	4.43	3.00
2900	*Eshelman's Certified Fitting Ration.* John W. Eshelman & Sons, Lancaster, Pa.	*Norwalk:* Frank Libner & Sons	10.75	5.59	14.06	12.00	6.78	7.00	58.39	4.43	3.50
2651	*Eshelman's Sack of Silage.* John W. Eshelman & Sons, Lancaster, Pa.	*Wallingford:* A. E. Hall	10.63	9.18	11.75	10.00	14.25	15.00	52.26	1.93	1.50
2990	*Eshelman's.* John W. Eshelman & Sons, Lancaster, Pa.	*New Britain:* Wm. Cohen	8.43	4.35	9.94	9.00	10.45	11.00	62.23	4.60	3.00
2663	*Red Wing.* Meech & Stoddard Inc., Middletown	*East Hartford:* Meech Grain Co.	9.85	5.48	8.88	9.00	11.30	12.00	60.14	4.35	3.00
2570	*Moon's.* Geo. Q. Moon & Co., Binghamton, N. Y.	*Stratford:* Z. C. Ingersoll	9.03	4.48	9.13	9.00	10.93	12.00	61.38	5.05	3.00
970	*Old Mill Fitting Feed.* Fred C. Morse & Son, Guilford	*Guilford:* Fred C. Morse & Son	11.08	7.29	13.88	12.00	5.65	8.00	58.02	4.08	4.00
1274	*Newtrio Growing & Fitting Ration.* Newton Feed Co., Milwaukee, Wis.	*Farmington:* Winchell Smith Grist Mill	8.68	9.21	14.06	12.00	7.33	9.00	55.54	5.18	5.00
2775	*Uncle John's Molasses.* Ontario Milling Co., Inc., Oswego, N. Y.	*Middletown:* P. Levson & Son	10.70	5.38	11.94	9.00	9.43	12.00	59.05	3.50	3.00
2766	*Bison, Sweetened.* Park & Pollard Co., Buffalo, N. Y.	*Stafford Springs:* Dennis Grain Mill	11.28	6.98	9.94	10.00	9.95	12.00	59.27	2.58	3.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	*Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein: Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Stock Feeds—Concluded		%	%	%	%	%	%	%	%	%
2768	*Fitting Ration.* Park & Pollard Co., Buffalo, N. Y.	*Putnam:* Bosworth Bros.	11.35	7.24	14.13	12.00	6.55	7.00	56.88	3.85	3.50
2755	*P & P.* Park & Pollard Co., Buffalo, N. Y.	*Thomaston:* Thomaston Grain & Coal Co.	9.18	6.15	11.88	8.50	9.45	12.00	58.94	4.40	4.00
2642	*Quaker Schumacher.* Quaker Oats Co., Chicago, Ill.	*Kensington:* S. F. Labieniec	9.03	5.93	10.63	10.00	10.20	12.00	59.88	4.33	3.25
2521	*Quaker Sugared Schumacher.* Quaker Oats Co., Chicago, Ill.	*Colchester:* J. Buratz	9.83	5.15	11.13	10.00	10.40	12.00	60.24	3.25	3.25
2903	*White Star, Fine.* Quaker Oats Co., Chicago, Ill.	*Norwalk:* Frank Libner & Sons	8.45	5.31	9.50	9.00	13.23	14.00	59.21	4.30	3.00
2495	*Purina Blue Checker Cow Chow.* Ralston Purina Co., St. Louis, Mo.	*New London:* New London Grain Co.	10.00	6.97	20.56	20.00	10.50	12.00	47.52	4.45	3.00
2497	*Purina Fitting Chow Feed.* Ralston Purina Co., St. Louis, Mo.	*New London:* New London Grain Co.	11.75	6.41	14.00	13.50	8.83	12.00	54.91	4.10	2.60

2800	*Purina.* Ralston Purina Co., St. Louis, Mo.	*Manchester:* Manchester Grain Co.	9.98	5.59	10.13	7.20	10.23	12.00	61.17	2.90	2.30
2583	*Ansonia.* I. Sovitsky Grain & Coal Co., Ansonia	*Ansonia:* I. Sovitsky Grain & Coal Co.	9.43	5.65	9.25	9.56	11.03	10.39	60.66	3.98	4.67
2519	*King.* St. Albans Grain Co., St. Albans, Vt.	*Norwich:* Norwich Grain Co.	9.15	4.67	9.88	9.00	10.03	10.00	60.02	6.25	4.00
2491	*Wirthmore 14 Fitting Ration.* St. Albans Grain Co., St. Albans, Vt.	*Chester:* Leete Bros.	11.38	6.28	14.75	14.00	6.20	7.00	57.11	4.28	4.00
2561	*Wirthmore.* St. Albans Grain Co., St. Albans, Vt.	*Milford:* Milford Grain Co.	9.20	4.45	9.06	9.00	10.33	9.50	61.91	5.05	4.00
2537	*Syragold.* Syracuse Milling Co., Syracuse, N. Y.	*Colchester:* P. Cutler, Inc.	9.45	4.68	9.44	9.00	9.83	12.00	63.02	3.58	3.00
2548	*Or-Co.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Guilford:* F. H. Rolf, Inc.	11.83	7.10	17.63	15.00	7.50	10.00	52.59	3.35	3.50
2486	*Uncas.* Yantic Grain & Products Co., Norwich	*Mystic:* Mystic Grain Co.	9.90	5.77	9.25	9.00	8.70	12.00	62.78	3.60	4.00
2825	*Uncas, Sugared.* Yantic Grain & Products Co., Norwich	*Mystic:* Mystic Grain Co.	10.15	4.85	8.13	9.00	10.38	12.00	62.51	3.98	4.00
	Calf Feeds, Etc.										
2598	*Eastern States.* Eastern States Farmers' Exchange, Springfield, Mass.	*Norwich:* A. E. Shedd	11.55	4.28	11.00	10.50	5.63	6.50	63.74	3.80	3.50
2750	*Beacon.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Bethlehem:* A. T. Minor	9.25	4.33	24.63	25.00	2.88	6.00	54.86	4.05	3.00
1119	*Blatchford's.* Blatchford Calf Meal Co., Waukegan, Ill.	*New Milford:* Geo. T. Soule	10.00	7.83	24.94	24.00	5.85	6.75	46.70	4.68	5.00
2694	*Blatchford's.* Blatchford Calf Meal Co., Waukegan, Ill.	*Farmington:* Winchell Smith Grist Mill	9.90	7.63	25.00	24.00	5.03	6.75	47.56	4.88	5.00
1017	*Elmore "Three Point."* Elmore Milling Co., Oneonta, N. Y.	*Hazardville:* Amos D. Bridge's Sons	9.88	6.46	16.00	24.00	2.60	4.00	61.46	3.60	4.00
1325	*Elmore "Three Point."* Elmore Milling Co., Oneonta, N. Y.	*Hazardville:* Amos D. Bridge's Sons	10.68	4.65	24.31	24.00	3.83	4.00	52.71	3.82	4.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein: Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Calf Feeds, Etc.—Concluded		%	%	%	%	%	%	%	%	%
2957	*Just Right.* Jersee Co., Minneapolis, Minn.	*Guilford:* Fred C. Morse & Son	10.20	4.41	24.75	23.00	4.65	4.00	50.94	5.05	3.80
1045	*Larro Hog Feed.* Larrowe Milling Co., Detroit, Mich.	*Collinsville:* Lawton-Miner Co.	8.43	6.30	19.06	18.00	9.35	10.00	51.08	5.78	5.00
1135	*Milkade.* Park & Pollard Co., Buffalo, N. Y.	*East Winsted:* Leonard Grain Co.	8.75	7.45	24.13	20.00	5.55	7.50	46.22	7.90	7.00
2646	*Schumacher.* Quaker Oats Co., Chicago, Ill.	*Hazardville:* A. D. Bridge's Sons	8.18	5.20	20.38	18.00	3.48	4.00	55.36	7.40	8.00
2660	*Purina Calf Chow Feed containing Mineral.* Ralston Purina Co., St. Louis, Mo.	*Farmington:* Winchell Smith Grist Mill	10.33	5.33	27.69	27.00	4.35	4.50	47.85	4.45	3.20
1188	*Purina Hog Fatena Feed containing Charcoal.* Ralston Purina Co., St. Louis, Mo.	*Norwich:* Norwich Grain Co.	13.38	6.63	15.06	14.00	5.83	6.00	55.65	3.45	3.00
1189	*Purina Pig Chow Feed containing Charcoal.* Ralston Purina Co., St. Louis, Mo.	*Norwich:* Norwich Grain Co.	11.65	8.79	21.88	20.00	6.43	7.00	46.94	4.31	3.20

2560	*Wirthmore.* St. Albans Grain Co., St. Albans, Vt.	*Milford:* Milford Grain Co.	9.48	5.38	23.63	24.00	2.65	4.00	54.13	4.73	5.50
2778	*Wirthmore Hog Feed.* St. Albans Grain Co., St. Albans, Vt.	*Granby:* E. H. Rollins	10.03	7.14	16.63	15.00	5.13	7.00	55.22	4.85	4.50
2783	*Wirthmore Pig Feed.* St. Albans Grain Co., St. Albans, Vt.	*West Willington:* H. M. Hansen	9.95	10.83	20.75	17.00	5.28	9.00	48.01	5.18	4.00
936	*Tioga.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Guilford:* F. H. Rolf, Inc.	9.65	6.59	22.19	21.00	4.60	7.00	51.84	5.13	4.00
937	*Wayne.* Wayne Feed Mills, Ft. Wayne, Ind.	*New Britain:* New Britain Bird Store	8.30	9.12	25.00	24.00	6.78	6.50	45.37	5.43	4.00
	Poultry Feeds										
2607	*Amco Egg Mash.* American Milling Co., Peoria, Ill.	*Danbury:* C. S. Barnum & Son ..	9.60	8.68	20.06	20.00	4.75	7.00	51.56	5.35	4.00
• 2658	*Arcady Besbet Laying Mash.* Arcady Farms Milling Co., Chicago, Ill.	*Meriden:* Raymond Ives	9.58	7.93	18.25	20.00	7.15	9.00	52.91	4.18	4.00
2989	*Arcady Besbet Laying Mash.* Arcady Farms Milling Co., Chicago, Ill.	*New Britain:* S. P. Strople	8.70	13.30	19.88	20.00	5.73	9.00	47.84	4.55	4.00
2659	*Arcady Scratch Grains.* Arcady Farms Milling Co., Chicago, Ill.	*Meriden:* Raymond Ives	12.25	1.65	10.50	10.00	2.63	5.00	70.07	2.90	2.50
2807	*Pennant Scratch Feed.* E. W. Bailey & Co., Montpelier, Vt..	*West Willington:* H. M. Hansen	12.15	1.26	9.38	10.00	2.43	6.50	72.25	2.53	3.00
2577	*Auburn Scratch Feed.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Shelton:* Shelton Feed Co.	12.18	1.78	9.94	9.00	2.45	5.00	71.30	2.35	2.50
1078	*Beacon Broiler Feed.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Danbury:* C. S. Barnum & Son ..	9.85	7.10	16.81	16.00	4.38	6.00	57.06	4.80	4.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
			Water	Ash	Protein (N x 6.25)		Fiber		Nitrogen-free extract (starch, gum, etc.)	Fat	
					Found	Guaranteed, not less than	Found	Guaranteed, not more than		Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Poultry Feeds—Continued		%	%	%	%	%	%	%	%	%
2872	*Beacon Complete Starting Ration.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Southbury:* H. R. Stone	9.50	5.68	17.50	16.50	4.03	6.00	57.74	5.55	4.00
1080	*Beacon Developer Feed.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Danbury:* C. S. Barnum & Son	10.05	1.95	12.19	10.00	2.00	5.00	70.26	3.55	2.50
2871	*Beacon Duck Fattener.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Southbury:* H. R. Stone	9.50	6.82	15.50	14.00	4.23	5.50	58.85	5.10	5.00
2870	*Beacon Duck Starter.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Southbury:* H. R. Stone	8.55	7.75	17.75	17.00	5.00	6.00	55.82	5.13	4.50
1075	*Beacon Chick Feed.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Danbury:* C. S. Barnum & Son	11.05	1.92	12.00	10.00	1.60	3.00	69.03	4.40	2.50

1061	*Beacon Egg Mash, with Buttermilk.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Shelton:* Shelton Feed Co.	8.45	12.14	20.69	21.00	6.13	7.00	47.79	4.80	4.50
1076	*Beacon Growing Mash.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Danbury:* C. S. Barnum & Son	8.05	10.20	18.06	17.00	5.43	7.00	53.18	5.08	4.00
1079	*Beacon Laying Mash.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Danbury:* C. S. Barnum & Son	8.58	12.76	20.69	20.00	6.33	8.00	45.84	5.80	5.00
2608	*Beacon Scratch Grains.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Danbury:* C. S. Barnum & Son	12.20	1.48	10.06	9.00	2.60	5.00	71.41	2.25	2.00
2866	*Beacon Special Scratch.* Beacon Milling Co., Inc., Cayuga, N. Y.	*New Milford:* W. L. Richmond	11.70	1.55	10.13	9.00	2.53	3.50	71.89	2.20	2.50
1074	*Beacon Starting Mash.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Southbury:* H. R. Stone	9.20	10.12	15.75	15.00	5.28	6.00	55.22	4.43	4.00
2576	*Beacon Turkey Growing Mash.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Shelton:* Shelton Feed Co.	9.43	11.05	15.25	15.00	6.83	6.00	52.64	4.80	4.00
2995	*Beacon Turkey Growing Mash.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Shelton:* Shelton Feed Co.	9.25	10.79	15.50	15.00	5.88	6.00	53.60	4.98	4.00
1062	*Cayuga Laying Mash, with Buttermilk.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Shelton:* Shelton Feed Co.	8.80	8.58	20.69	20.00	6.33	7.00	50.35	5.25	4.00
1077	*Chariot Chick Feed.* Beacon Milling Co., Inc., Cayuga, N. Y.	*Danbury:* C. S. Barnum & Son	11.88	1.82	10.88	10.00	1.65	5.00	69.82	3.95	2.50
2555	*Beers' Laying Mash.* Ira W. Beers, Hamden	*Hamden:* Ira W. Beers	10.08	6.69	19.00	19.00	6.23	7.00	52.97	5.03	5.50
2983	*Beers' Laying Mash.* Ira W. Beers, Hamden	*Hamden:* Ira W. Beers	10.18	8.09	19.88	19.00	6.28	7.00	50.24	5.33	5.50

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
			Water	Ash	Protein (N x 6.25)		Fiber		Nitrogen-free extract (starch, gum, etc.)	Fat	
					Found	Guaranteed, not less than	Found	Guaranteed, not more than		Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Poultry Feeds—Continued		%	%	%	%	%	%	%	%	%
957	*Beers' Scratch Feed.* Ira W. Beers, Hamden	*Hamden:* Ira W. Beers	12.10	1.72	10.50	9.00	2.73	4.00	70.00	2.95	3.00
1161	*Bristol Mash.* Bristol Grain & Supply Co., Bristol	*Bristol:* Bristol Grain & Supply Co.	9.75	9.03	19.75	18.00	6.25	10.00	50.72	4.50	4.00
1050	*Bristol Scratch Feed.* Bristol Grain & Supply Co., Bristol	*Bristol:* Bristol Grain & Supply Co.	11.55	1.92	10.06	10.00	2.90	4.00	69.29	4.28	3.00
972	*C. B. Growing Mash.* C. Buckingham & Co., Southport	*Southport:* C. Buckingham & Co.	11.20	7.93	15.19	15.00	4.18	6.00	57.32	4.18	4.00
1247	*C. B. Mash.* C. Buckingham & Co., Southport	*Southport:* C. Buckingham & Co.	10.15	8.97	19.50	19.00	6.09	8.00	50.36	4.93	5.00
1249	*C. B. Scratch Feed.* C. Buckingham & Co., Southport	*Southport:* C. Buckingham & Co.	13.63	1.57	10.06	11.00	3.09	3.75	69.36	2.29	2.75
2895	*C. B. Scratch Feed.* C. Buckingham & Co., Southport	*Southport:* C. Buckingham & Co.	11.83	1.57	10.81	11.00	3.25	3.75	69.96	2.58	2.75
2978	*Chicken Greens.* California Hawaiian Milling Co., San Francisco, Cal.	*Groton:* C. W. Campbell Co.	8.20	13.40	20.06	20.00	17.00	18.00	38.69	2.65	....

1192	*Egg-O-Dry Mash.* C. W. Campbell Co., Westerly, R. I.	*Groton:* C. W. Campbell Co. ...	10.23	8.91	20.13	18.00	6.61	8.00	49.57	4.55	2.00
2504	*Egg-O-Scratch Feed.* C. W. Campbell Co., Westerly, R. I..	*Groton:* C. W. Campbell Co. ...	12.25	1.68	10.75	10.00	3.00	5.00	69.62	2.70	2.00
1133	*Chapin Kernels Grow-All.* Chapin & Co., Hammond, Ind.	*Torrington:* D. L. Talcott	8.30	10.35	16.44	16.00	4.53	5.50	56.30	4.08	3.50
1011	*Chapin Kernels Lay-All.* Chapin & Co., Hammond, Ind.	*Collinsville:* Rourke - Robotham Co.	7.73	10.91	18.50	16.00	4.50	5.50	54.91	3.45	3.50
1132	*Chapin Kernels Start All.* Chapin & Co., Hammond, Ind.	*Torrington:* D. L. Talcott	8.10	9.25	15.94	15.00	4.10	4.50	58.24	4.37	3.50
2623	*Unicorn Egg Mash (with Buttermilk).* Chapin & Co., Hammond, Ind.	*Danbury:* F. C. Benjamin	9.20	11.53	21.00	20.00	5.53	7.00	47.84	4.90	4.50
959	*Fortune Chick Starter.* The Coles Co., Middletown	*Plantsville:* Mehmel & Sarvi ...	9.30	9.94	15.94	14.00	5.83	5.00	53.56	5.43	5.00
1194	*Fortune Egg Mash, with Dried Buttermilk.* The Coles Co., Middletown	*Middletown:* The Coles Co. ...	9.75	11.00	20.50	17.00	5.30	9.00	47.97	5.48	3.50
1193	*Fortune Growing Feed.* The Coles Co., Middletown	*Middletown:* The Coles Co. ...	9.63	9.10	16.88	10.00	5.92	8.00	53.24	5.23	1.50
958	*Fortune Intermediate Scratch Feed.* The Coles Co., Middletown ..	*Plantsville:* Mehmel & Sarvi ...	12.08	1.32	10.56	10.00	1.93	3.00	71.76	2.35	5.00
1195	*Fortune Scratch Feed.* The Coles Co., Middletown	*Middletown:* The Coles Co. ...	13.75	1.54	9.56	10.00	2.96	5.00	68.99	3.20	2.50
1126	*Conkey's Gecco Chick Grains.* G. E. Conkey Co., Cleveland, Ohio	*Ansonia:* A. Hodos & Son	12.35	2.15	9.63	10.00	1.45	2.50	71.59	2.83	2.00
1125	*Conkey's Gecco Egg Mash, with Y-O.* G. E. Conkey Co., Cleveland, Ohio	*Ansonia:* A. Hodos & Son	9.50	10.98	22.13	20.00	5.13	7.00	45.06	7.20	5.00
2743	*Conkey's Gecco Egg Mash, with Buttermilk.* G. E. Conkey Co., Cleveland, Ohio	*Ansonia:* A. Hodos & Son	9.43	10.00	20.69	20.00	4.33	7.00	49.95	5.60	5.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
			Water	Ash	Protein (N x 6.25)		Fiber		Nitrogen-free extract (starch, gum, etc.)	Fat	
					Found	Guaranteed, not less than	Found	Guaranteed, not more than		Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Poultry Feeds—Continued		%	%	%	%	%	%	%	%	%
1199	*Conkey's Gecco Growing Grains.* G. E. Conkey Co., Cleveland, Ohio	*New Haven:* Frank S. Platt Co.	12.15	1.78	10.06	10.50	1.79	3.00	70.07	4.15	2.50
1124	*Conkey's Gecco Growing Mash, with Buttermilk and Y-O.* G. E. Conkey Co., Cleveland, Ohio	*Ansonia:* A. Hodos & Son	9.50	9.67	20.75	18.00	5.82	7.50	48.18	6.08	5.50
1122	*Conkey's Gecco Scratch Grains.* G. E. Conkey Co., Cleveland, Ohio	*Ansonia:* A. Hodos & Son	13.00	1.36	9.63	9.75	2.79	3.00	70.52	2.70	2.50
1123	*Conkey's Scratch Grains.* G. E. Conkey Co., Cleveland, Ohio	*Ansonia:* A. Hodos & Son	12.70	1.41	10.44	9.75	3.06	3.50	69.89	2.50	1.75
1198	*Conkey's (The Original) Starting Feed, with Buttermilk and Y-O.* G. E. Conkey Co., Cleveland, Ohio	*Middletown:* Meech & Stoddard, Inc.	10.88	6.08	14.94	14.00	3.84	5.00	58.53	5.73	5.50

2667	*C. A. Blue Seal Mash.* C. A. Cowles, Plantsville	*Plantsville:* C. A. Cowles	10.10	10.85	18.19	18.00	6.23	6.00	49.73	4.90	4.00
1098	*Cowles' Scratch.* C. A. Cowles, Plantsville	*Plantsville:* C. A. Cowles	12.68	1.53	9.63	10.00	3.05	5.00	69.88	3.23	1.50
1206	*Crosby's Egg Mash.* Crosby Milling Co., Brattleboro, Vt...	*Manchester:* O. E. Bailey	10.10	10.70	19.00	20.00	6.02	7.00	49.23	4.95	4.00
1204	*Crosby's Gritless Chick Feed.* Crosby Milling Co., Brattleboro, Vt.	*Shelton:* Wolf Savitsky	12.78	1.60	11.06	11.00	2.04	3.50	70.19	2.33	2.50
1205	*Crosby's Growing Feed.* Crosby Milling Co., Brattleboro, Vt...	*Manchester:* O. E. Bailey	11.00	10.76	18.00	15.00	5.03	4.50	50.21	5.00	4.50
2799	*Crosby's Intermediate Chick Feed.* Crosby Milling Co., Brattleboro, Vt.	*Manchester:* O. E. Bailey	11.68	1.53	11.25	10.00	1.80	3.50	70.26	3.48	2.50
1071	*Crosby's Scratch Feed.* Crosby Milling Co., Brattleboro, Vt...	*Shelton:* Wolf Savitsky	12.50	1.58	10.25	11.00	3.03	5.00	69.61	3.03	3.00
1120	*Davis Buttermilk Mash Feed.* R. G. Davis & Sons, New Haven	*Ansonia:* Ansonia Flour & Feed Co.	10.05	8.18	19.06	18.00	5.64	8.00	51.39	5.68	3.50
1121	*Davis Scratch Feed.* R. G. Davis & Sons, New Haven	*Ansonia:* Ansonia Flour & Feed Co.	13.40	1.74	10.50	10.00	2.99	5.00	68.69	2.68	2.00
1100	*Delaware Chick Grains.* Delaware Mills, Inc., Deposit, N. Y.	*Southington:* Southington Lumber Co.	12.53	1.18	10.13	10.00	1.58	3.00	72.73	1.85	3.00
961	*Delaware Chick Starting Mash.* Delaware Mills, Inc., Deposit, N. Y.	*Southington:* Southington Lumber Co.	10.28	9.00	17.63	15.00	5.40	5.00	51.86	5.83	4.00
1099	*Double Circle Scratch Grains.* Delaware Mills, Inc., Deposit, N. Y.	*Southington:* Southington Lumber Co.	13.78	1.74	10.88	10.00	3.20	5.00	68.05	2.35	2.50
2672	*Delaware Growing Mash (with Dried Buttermilk).* Delaware Mills, Inc., Deposit, N. Y. ...	*Southington:* Southington Lumber Co.	9.65	10.88	18.75	17.00	5.40	6.00	49.44	5.88	6.00
1016	*Delaware Scratch Grains.* Delaware Mills, Inc., Deposit, N. Y.	*Thompsonville:* Geo. S. Phelps & Co.	11.50	1.65	10.75	10.00	3.13	5.00	70.39	2.58	2.50

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
			Water	Ash	Protein (N x 6.25)		Fiber		Nitrogen-free extract (starch, gum, etc.)	Fat	
					Found	Guaranteed, not less than	Found	Guaranteed, not more than		Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Poultry Feeds—Continued										
			%	%	%	%	%	%	%	%	%
2898	*Indian Laying Mash, with Dried Buttermilk.* Delaware Mills, Inc., Deposit, N. Y.	*Norwalk:* Frank Libner & Sons	10.03	8.25	17.88	18.00	5.83	7.00	51.98	6.03	4.00
1088	*Indian Scratch Grains.* Delaware Mills, Inc., Deposit, N. Y. ...	*Norwalk:* Frank Libner & Sons	13.68	1.45	10.31	10.00	2.69	5.00	69.37	2.50	2.50
2767	*Eastern States Egg Mash, Open Formula.* Eastern States Farmers' Exchange, Springfield, Mass.	*Abington:* Joseph Stoddard	9.50	11.32	18.19	16.50	5.98	6.50	60.28	4.73	4.00
2484	*Eastern States Milk Egg Mash, Open Formula.* Eastern States Farmers' Exchange, Springfield, Mass.	*Clinton:* A. L. Lockwood	10.13	9.62	18.88	16.50	5.10	6.50	51.39	4.88	4.00

2482	*Eastern States Scratch Grains (with Coarse Cracked Corn, Open Formula)*. Eastern States Farmers' Exchange, Springfield, Mass.	*Clinton:* A. L. Lockwood	12.15	1.73	10.69	9.50	2.88	4.00	69.55	3.00	2.50
2757	*Eastern States Starting & Growing Mash, Open Formula.* Eastern States Farmers' Exchange, Springfield, Mass.	*North Haven:* Ridgewood Farm	9.88	9.10	17.25	16.00	4.05	6.00	54.89	4.83	4.00
1094	*Chixsaver.* Elmore Milling Co., Oneonta, N. Y.	*Newtown:* R. H. Holcomb & Co.	10.78	9.13	19.13	18.00	3.93	8.00	52.65	4.38	4.00
1065	*Elmore Egg Mash.* Elmore Milling Co., Oneonta, N. Y.	*Shelton:* Wolf Savitsky	10.10	7.80	16.75	18.00	4.10	8.00	56.30	4.95	4.00
1064	*Elmore Scratch Feed.* Elmore Milling Co., Oneonta, N. Y.	*Shelton:* Wolf Savitsky	12.00	1.61	11.00	10.00	2.65	7.00	70.54	2.20	3.50
2515	*Elmore Scratch Feed.* Elmore Milling Co., Oneonta, N. Y.	*Norwich:* A. E. Shedd	12.35	1.72	10.63	10.00	2.95	7.00	69.30	3.05	3.50
1093	*Elmore Storrs Formula Laying Mash.* Elmore Milling Co., Oneonta, N. Y.	*Newtown:* R. H. Holcomb & Co.	10.13	7.04	17.38	18.00	6.28	7.00	53.27	5.90	4.00
1102	*Emco Scratch Feed.* Elmore Milling Co., Oneonta, N. Y.	*Hazardville:* A. D. Bridge's Sons	11.83	1.67	10.69	10.00	2.73	7.00	70.70	2.38	3.50
964	*Eshelman's Baby Chick Starter.* John W. Eshelman & Sons, Lancaster, Pa.	*Wallingford:* A. E. Hall	9.10	4.54	15.63	14.00	4.90	6.00	61.78	4.05	4.00
2992	*Eshelman's Fattening Mash.* John W. Eshelman & Sons, Lancaster, Pa.	*New Britain:* Wm. Cohen	9.58	7.40	16.56	14.00	3.88	5.00	56.23	6.35	4.00
2661	*Eshelman's Growing Mash.* John W. Eshelman & Sons, Lancaster, Pa.	*Simsbury:* Woods-Chandler Co.	10.45	6.78	18.56	16.00	5.80	7.00	52.36	6.05	4.00
1084	*Eshelman's Laying Mash.* John W. Eshelman & Sons, Lancaster, Pa.	*Devon:* Devon Coal & Ice Co.	9.50	8.18	21.56	20.00	5.83	7.00	48.83	6.10	5.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
			Water	Ash	Protein (N x 6.25)		Fiber		Nitrogen-free extract (starch, gum, etc.)	Fat	
					Found	Guaranteed, not less than	Found	Guaranteed, not more than		Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Poultry Feeds—Continued										
			%	%	%	%	%	%	%	%	%
956	*Eshelman's Scratch Feed.* John W. Eshelman & Sons, Lancaster, Pa.	*Hamden:* Ira W. Beers	13.15	1.58	10.13	10.00	2.38	4.00	70.26	2.50	2.50
1087	*Imperial Scratch Feed.* John W. Eshelman & Sons, Lancaster, Pa.	*Southport:* C. Buckingham & Co.	11.95	1.59	10.31	9.00	3.15	4.00	70.47	2.53	2.50
2601	*Pennsy Laying Mash.* John W. Eshelman & Sons, Lancaster, Pa.	*Devon:* Devon Coal & Ice Co.	9.85	8.35	20.56	18.00	7.80	8.00	46.99	6.45	5.00
2562	*Pennsy Scratch Feed.* John W. Eshelman & Sons, Lancaster, Pa.	*Devon:* Devon Coal & Ice Co.	12.40	1.70	9.69	9.00	2.73	4.00	70.88	2.60	2.50
1012	*Flory's Egg Mash.* Flory Milling Co., Bangor, Pa.	*Bloomfield:* Bloomfield Farmers' Exchange	8.95	10.88	19.69	20.00	5.80	8.00	49.50	5.18	4.50
2790	*Flory's Scratch Feed.* Flory Milling Co., Bangor, Pa.	*Bloomfield:* Bloomfield Farmers' Exchange	12.30	1.47	10.13	9.00	2.75	4.00	70.52	2.83	2.50

1013	*Sunray Scratch Feed.* Flory Milling Co., Bangor, Pa.	*Bloomfield:* Bloomfield Farmers' Exchange	12.13	1.49	9.81	9.00	2.73	5.00	71.34	2.50	2.50
2441	*R Own Laying Mash.* F. A. Forbes, East Haven	*East Haven:* F. A. Forbes	11.03	6.51	17.81	18.00	5.77	8.00	53.80	5.08	4.00
2446	*R Own Scratch Feed.* F. A. Forbes, East Haven	*East Haven:* F. A. Forbes	13.15	1.82	10.31	10.00	2.69	5.00	68.53	3.50	3.00
2857	*Washburn's Gold Medal Developing Feed—No Grit.* General Mills, Inc., Minneapolis, Minn.	*Riverton:* L. A. Coe	12.50	1.26	10.19	10.00	2.20	5.00	71.52	2.33	2.50
2931	*Grandin's Growing Feed.* D. H. Grandin Milling Co., Jamestown, N. Y.	*Falls Village:* H. E. Dean	9.45	13.79	15.75	14.00	6.48	8.00	50.08	4.45	4.00
2925	*Grandin's Laying Mash with Buttermilk.* D. H. Grandin Milling Co., Jamestown, N. Y.	*Falls Village:* H. E. Dean	9.68	13.50	21.75	20.00	5.53	8.00	45.41	4.13	4.00
2924	*Grandin's Screened Scratch Feed.* D. H. Grandin Milling Co., Jamestown, N. Y.	*Falls Village:* H. E. Dean	12.25	1.63	10.00	10.00	3.15	5.00	70.17	2.80	2.50
2500	*Red Comb Chick Starter, with Dried Buttermilk.* Hales & Hunter Co., Chicago, Ill.	*New London:* B. J. McCarthy..	9.05	10.14	16.56	14.00	5.18	5.00	54.74	4.33	4.00
2703	*Red Comb Duck Fattener.* Hales & Hunter Co., Chicago, Ill. ...	*Hamden:* Ira W. Beers	10.35	6.60	14.94	15.00	4.18	5.00	59.80	4.13	3.50
2702	*Red Comb Duck Grower.* Hales & Hunter Co., Chicago, Ill. ...	*Hamden:* Ira W. Beers	10.23	8.18	18.31	18.00	6.43	7.00	52.12	4.73	3.50
2501	*Red Comb Egg Mash, with Dried Buttermilk.* Hales & Hunter Co., Chicago, Ill.	*New London:* B. J. McCarthy..	9.15	10.60	17.19	15.00	6.20	6.00	52.31	4.55	4.00
2502	*Red Comb Growing Mash, with Buttermilk.* Hales & Hunter Co., Chicago, Ill.	*New London:* B. J. McCarthy..	9.38	10.11	16.75	14.00	5.93	6.00	53.23	4.60	4.00
2499	*Red Comb Scratch Feed.* Hales & Hunter Co., Chicago, Ill. ...	*New London:* B. J. McCarthy..	11.68	1.78	10.88	10.00	2.93	5.00	69.65	3.08	2.50

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein: Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Poultry Feeds—Continued		%	%	%	%	%	%	%	%	%
2794	*"Hudson's" Developing Mash.* L. W. Hudson, Windsor	*Windsor:* L. W. Hudson	10.08	9.00	16.25	17.00	7.05	5.25	52.87	4.75	5.85
1014	*Hudson's Laying Mash.* L. W. Hudson, Windsor	*Windsor:* L. W. Hudson	9.93	9.45	17.69	18.00	6.85	5.50	50.73	5.35	5.50
2759	*Just Right Egg Mash.* Jersee Co., Minneapolis, Minn.	*Guilford:* Fred C. Morse & Son	9.28	7.38	22.75	20.00	9.48	8.00	44.68	6.43	4.00
2927	*Blue Top Egg Mash.* Chas A. Krause Milling Co., Milwaukee, Wis.	*Thomaston:* I. Levy	9.30	5.63	18.63	20.00	7.23	7.50	53.93	5.28	5.00
965	*Dry Mash.* S. F. Labieniec, Kensington	*Kensington:* S. F. Labieniec	9.20	10.14	19.75	19.00	7.35	8.00	48.43	5.13	5.00
1063	*Larro Chick Grains.* Larrowe Milling Co., Detroit, Mich.	*Shelton:* Wolf Savitsky	10.68	1.29	11.25	10.00	1.50	3.50	72.70	2.58	2.50
1042	*Larro Chick Starter.* Larrowe Milling Co., Detroit, Mich.	*Collinsville:* Lawton-Miner Co.	8.85	6.24	15.13	14.00	5.53	6.50	57.70	6.55	4.50
1070	*Larro Growing Grains.* Larrowe Milling Co., Detroit, Mich.	*Shelton:* Wolf Savitsky	12.43	1.33	10.69	10.00	1.98	4.00	70.72	2.85	3.00

1044	*Larro Egg Mash.* Larrowe Milling Co., Detroit, Mich. ...	*Collinsville:* Lawton-Miner Co..	7.75	12.14	20.38	19.00	7.15	8.00	46.43	6.15	5.00
1043	*Larro Growing Mash.* Larrowe Milling Co., Detroit, Mich. ...	*Collinsville:* Lawton-Miner Co..	9.15	8.83	17.13	16.00	5.63	6.50	53.81	5.45	5.00
2689	*Homestead Dry Mash.* C. W. Lines Co., New Britain	*New Britain:* C. W. Lines Co...	9.53	11.40	19.63	18.00	6.78	7.00	47.58	5.08	4.00
967	*Homestead Scratch Feed.* C. W. Lines Co., New Britain	*New Britain:* C. W. Lines Co...	11.78	1.60	10.38	9.00	2.78	5.00	71.01	2.45	2.50
966	*Mill Pride Fancy Scratch Feed.* C. W. Lines Co., New Britain	*New Britain:* C. W. Lines Co...	12.18	1.89	10.63	10.00	2.78	5.00	69.67	2.85	3.00
2687	*Mill Pride Milk Mash.* C. W. Lines Co., New Britain	*New Britain:* C. W. Lines Co...	8.98	12.75	18.88	18.00	7.33	7.50	47.51	4.55	5.00
2934	*Common Sense Growing Mash.* Litchfield County Coöperative Association, Torrington	*Torrington:* Litchfield Co-op. Assoc.	9.73	8.31	16.63	15.00	5.43	7.00	55.22	4.68	4.00
2933	*Common Sense Laying Mash.* Litchfield County Coöperative Association, Torrington	*Torrington:* Litchfield Co-op. Assoc.	10.13	7.71	16.00	15.00	5.65	7.00	56.06	4.45	4.00
2887	*Square Deal Buttermilk Laying Mash.* Long Hill Feed Store, Long Hill	*Long Hill:* Long Hill Feed Store	7.50	14.67	20.38	20.00	6.80	7.00	45.55	5.10	5.00
1140	*Huntington Red Star Egg Mash.* E. Manchester & Sons, Winsted	*Winsted:* E. Manchester & Sons	9.93	11.93	16.25	15.00	6.44	6.00	50.96	4.49	4.00
1137	*Red Star Egg Mash.* E. Manchester & Sons, Winsted	*Winsted:* E. Manchester & Sons	11.58	10.31	18.38	16.00	6.28	8.00	47.82	5.63	4.00
1141	*Red Star Scratch Feed.* E. Manchester & Sons, Winsted	*Winsted:* E. Manchester & Sons	13.30	1.76	10.44	10.00	3.53	6.00	68.34	2.63	3.00
1138	*Red Star Starting and Growing Mash.* E. Manchester & Sons, Winsted	*Winsted:* E. Manchester & Sons	10.23	11.14	17.94	15.00	6.73	6.00	49.28	4.68	4.00
2867	*Bull Brand Laying Mash, with Dried Buttermilk.* Maritime Milling Co., Buffalo, N. Y. ..	*Brookfield:* S. A. Smith & Son	9.35	10.47	21.38	20.00	6.45	8.00	46.92	5.43	5.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
					Protein (N x 6.25)		Fiber			Fat	
			Water	Ash	Found	Guaranteed, not less than	Found	Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Poultry Feeds—Continued		%	%	%	%	%	%	%	%	%
1096	*Bull Brand Red-E-Mixt Egg Mash.* Maritime Milling Co., Buffalo, N. Y.	*New Milford:* Geo. E. Ackley Co.	9.83	9.75	18.31	18.00	6.45	9.00	50.68	4.98	5.00
1097	*Bull Brand Scratch Feed.* Maritime Milling Co., Buffalo, N. Y.	*New Milford:* Geo. E. Ackley Co.	10.83	1.65	10.94	10.00	3.55	4.00	70.38	2.65	2.50
1142	*Jersey Dry Mash.* Maritime Milling Co., Buffalo, N. Y.	*Riverton:* L. A. Coe	10.63	7.73	18.38	18.00	6.14	9.00	51.57	5.55	5.00
2440	*Red Wing Special Buttermilk Chick Starter.* Meech & Stoddard, Inc., Middletown	*Middletown:* Meech & Stoddard, Inc.	9.80	14.98	14.25	13.00	5.35	5.00	50.87	4.75	4.00
1197	*Red Wing Special Buttermilk Growing Feed.* Meech & Stoddard, Inc., Middletown	*Middletown:* Meech & Stoddard, Inc.	9.88	14.05	18.63	17.00	5.42	8.00	47.32	4.70	5.50
2772	*Red Wing Special Buttermilk Growing Feed.* Meech & Stoddard, Inc., Middletown	*Middletown:* Meech & Stoddard Inc.	8.93	12.62	18.56	17.00	6.60	8.00	48.04	5.25	5.50

1196	*Red Wing Special Buttermilk Laying Mash.* Meech & Stoddard, Inc., Middletown	*Middletown:* Meech & Stoddard, Inc.	10.63	11.13	17.00	17.00	6.13	8.00	50.23	4.88	5.50
1254	*Red Wing Special Chick Feed.* Meech & Stoddard, Inc., Middletown	*Middletown:* Meech & Stoddard, Inc.	15.23	1.52	9.63	10.00	4.00	5.00	67.24	2.38	3.00
2494	*Red Wing Special Intermediate Chick Feed.* Meech & Stoddard, Inc., *Middletown*	*Essex:* Meech & Stoddard, *Inc.*	12.45	1.85	11.38	10.00	2.88	5.00	68.14	3.30	3.00
2674	*Memo All Mash Ration.* Mennel Milling Co., Toledo, Ohio	*Plainville:* W. S. Eaton	10.10	8.75	16.88	16.00	4.40	5.00	54.04	5.83	4.50
2954	*Mennel's Mixed Grains.* Mennel Milling Co., Toledo, Ohio	*Plainville:* W. S. Eaton	11.80	1.35	9.94	10.00	2.75	5.00	71.33	2.83	3.00
2430	*Moon's Baby Chick Grains.* Geo. Q. Moon & Co., Binghamton, N. Y.	*Manchester:* I. W. Campbell ..	12.95	1.47	9.81	10.00	1.00	2.50	73.59	1.18	3.00
1127	*Moon's Laying Mash, with Dried Buttermilk.* Geo. Q. Moon & Co., Binghamton, N. Y.	*Waterville:* Wooster Feed Store	9.83	9.65	19.31	20.00	6.16	9.00	50.05	5.00	4.00
1163	*Moon's Scratch Feed.* Geo. Q. Moon & Co., Binghamton, N. Y.	*Manchester:* I. W. Campbell ...	13.30	1.46	9.94	10.00	3.18	5.00	69.67	2.45	2.00
3015	*Moon's Special A Laying Mash, with Buttermilk.* Geo. Q. Moon & Co., Binghamton, N. Y.	*Plainville:* F. B. Newton	7.85	12.86	19.88	18.00	6.50	9.00	46.91	6.00	5.00
2833	*C. B. Mash.* Moran-Paton Co., New Haven	*New Haven:* Moran & Patton Co.	9.58	8.35	18.44	18.00	7.52	7.00	50.41	5.70	4.00
2764	*Old Mill Growing Mash.* Fred C. Morse & Son, Guilford ...	*Guilford:* Fred C. Morse & Son	9.78	6.85	16.81	15.00	6.18	6.00	55.20	5.18	5.00
2761	*Old Mill Laying Mash.* Fred C. Morse & Son, Guilford ...	*Guilford:* Fred C. Morse & Son	9.33	11.95	21.13	19.00	6.18	8.00	45.93	5.48	4.50

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein (N x 6.25): Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued* *Poultry Feeds—Continued*		%	%	%	%	%	%	%	%	%
1034	*Old Mill Laying Mash, with Milk.* Fred C. Morse & Son, Guilford	*Guilford:* Fred C. Morse & Son	9.95	8.05	20.31	20.00	7.00	8.00	49.54	5.15	5.00
1036	*Old Mill Scratch Feed.* Fred C. Morse & Son, Guilford	*Guilford:* Fred C. Morse & Son	12.13	1.78	10.75	10.00	3.08	4.00	69.63	2.63	3.00
1219	*Genesee Scratch Grains.* Newman Bros. Grain Co., Rochester, N. Y.	*Hazardville:* Amos D. Bridge's Sons.	13.70	1.48	9.69	10.00	2.75	3.00	70.25	2.13	2.50
1049	*Mystic Laying Mash.* Newman Bros. Grain Co., Rochester, N. Y.	*Hazardville:* Amos D. Bridge's Sons.	8.83	14.56	19.19	17.00	5.90	10.00	46.49	5.03	4.00
2776	*Aunt Mary's Egg Mash, with Dried Buttermilk.* Ontario Milling Co., Oswego, N. Y.	*Middletown:* P. Levson & Son	9.25	11.72	20.19	19.00	5.78	8.50	47.43	5.63	4.00
1940	*Aunt Mary's Scratch Feed.* Ontario Milling Co., Oswego, N. Y.	*Collinsville:* Rourke - Robotham Co.	11.80	1.55	10.63	10.00	3.18	5.00	70.21	2.63	2.50

1041	*Oswego Egg Mash, with Meat and Fish.* Ontario Milling Co., Oswego, N. Y.	*Collinsville:* Rourke - Robotham Co.	8.45	12.88	18.00	18.00	6.35	8.50	49.02	5.30	4.00
1054	*Osborn Mash.* S. V. Osborn Est., Branford	*Branford:* S. V. Osborn Est. ..	9.78	6.17	14.38	12.00	6.40	8.00	59.69	3.58	3.00
1038	*Osborn Scratch.* S. V. Osborn Est., Branford	*Branford:* S. V. Osborn Est. ..	11.50	1.70	10.38	10.00	2.58	5.00	71.26	2.58	2.00
2884	*Bidwell Dry Mash.* Park & Pollard Co., Buffalo, N. Y.	*Bridgeport:* Samp Morter Mills	8.78	10.75	18.38	18.00	5.70	10.00	52.29	4.10	1.50
1057	*Bidwell Scratch Feed.* Park & Pollard Co., Buffalo, N. Y. ..	*Plainville:* F. B. Newton	11.95	1.79	10.63	10.00	2.85	5.00	69.60	3.18	1.50
1056	*Growing Feed.* Park & Pollard Co., Buffalo, N. Y.	*Plainville:* F. B. Newton	11.05	8.08	15.25	14.00	5.00	8.00	56.74	3.88	3.00
2789	*Intermediate Chick Feed.* Park & Pollard Co., Buffalo, N. Y. ..	*Bloomfield:* Bloomfield Farmers' Exchange	12.40	1.37	10.25	10.00	2.50	5.00	70.53	2.95	3.00
1055	*Lay or Bust Dry Mash.* Park & Pollard Co., Buffalo, N. Y. ..	*Plainville:* F. B. Newton	10.40	10.90	19.38	18.00	5.55	8.00	50.32	3.45	3.00
1066	*Park & Pollard Chick Starter.* Park & Pollard Co., Buffalo, N. Y.	*Shelton:* Shelton Feed Co.	12.20	5.71	14.94	14.00	4.10	5.00	59.85	3.20	3.00
928	*Red Ribbon Chick Feed.* Park & Pollard Co., Buffalo, N. Y. ..	*West Cheshire:* Cheshire Grain & Coal Co.	11.88	1.65	10.00	10.00	1.80	5.00	72.03	2.64	3.00
927	*Red Ribbon Scratch Feed.* Park & Pollard Co., Buffalo, N. Y. ..	*West Cheshire:* Cheshire Grain & Coal Co.	12.30	1.78	10.19	10.00	2.63	5.00	69.90	3.20	3.00
1200	*Platco Laying Mash.* Frank S. Platt Co., New Haven	*New Haven:* Frank S. Platt Co.	9.05	11.19	21.88	20.00	5.04	7.00	46.51	6.33	5.50
1201	*Platco Perfection Grain Mixture.* Frank S. Platt Co., New Haven	*New Haven:* Frank S. Platt Co.	12.13	1.70	10.31	10.00	3.49	3.50	69.27	3.10	3.00
1058	*Puritan Scratch Feed.* W. W. Potter & Sons, Greenfield, Mass.	*Bloomfield:* Bloomfield Farmers' Exchange	11.83	1.79	10.63	10.00	3.60	2.50	69.35	2.80	3.00
1089	*Pratt's Baby Chick Food, with Buttermilk.* Pratt Food Co., Buffalo, N. Y.	*Norwalk:* Frank Libner & Sons	9.68	7.98	13.06	13.00	3.05	3.80	61.85	4.38	3.50

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein: Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Poultry Feeds—Continued		%	%	%	%	%	%	%	%	%
1060	*Pratt's Circle A Chick Scratch Feed.* Pratt Food Co., Buffalo, N. Y.	*Thompsonville:* Geo. S. Phelps & Co.	10.93	1.16	10.00	10.00	1.50	5.00	74.23	2.18	2.00
929	*Pratt's Circle A Large Scratch Feed.* Pratt Food Co., Buffalo, N. Y.	*Bristol:* Bristol Grain & Supply Co.	12.63	1.47	9.69	10.00	2.73	5.00	71.02	2.46	2.50
1059	*Pratt's Supreme Growing Mash, with Buttermilk.* Pratt Food Co., Buffalo, N. Y.	*Thompsonville:* Geo. S. Phelps & Co.	7.53	12.53	19.13	17.50	5.35	7.00	50.23	5.23	4.50
1147	*Pratt's Victory Chick Scratch Feed.* Pratt Food Co., Buffalo, N. Y.	*New Britain:* S. P. Strople	11.48	6.40	10.63	10.00	1.45	5.00	67.51	2.53	2.00
1162	*Pratt's Victory Intermediate Scratch Feed.* Pratt Food Co., Buffalo, N. Y.	*New Britain:* S. P. Strople	12.68	1.31	10.13	10.00	1.65	5.00	72.10	2.13	2.00

2899	*Pratt's Victory Large Scratch Feed.* Pratt Food Co., Buffalo, N. Y.	*Norwalk:* Frank Libner & Sons	11.80	1.68	10.75	10.00	2.53	5.00	70.59	2.65	2.50
930	*Pratt's Victory Laying Mash, with Buttermilk.* Pratt Food Co., Buffalo, N. Y.	*Bristol:* Bristol Grain & Supply Co.	8.65	10.88	20.19	20.00	5.90	8.00	48.08	6.30	4.00
1082	*Quaker Ful-O-Pep Chick Starter.* Quaker Oats Co., Chicago, Ill.	*Devon:* Devon Coal & Ice Co. ..	8.30	7.98	15.75	15.00	5.58	6.00	56.19	6.20	5.00
1108	*Quaker Ful-O-Pep Egg Mash.* Quaker Oats Co., Chicago, Ill.	*Norwalk:* Frank Libner & Sons	8.30	10.07	20.06	20.00	6.52	8.00	49.45	5.60	4.00
1111	*Quaker Ful-O-Pep Fine Chick Feed.* Quaker Oats Co., Chicago, Ill.	*Seymour:* Seymour Grain & Coal Co.	10.45	1.63	11.81	11.00	1.80	2.00	71.03	3.28	2.50
1107	*Quaker Ful-O-Pep Growing Mash.* Quaker Oats Co., Chicago, Ill.	*Norwalk:* Frank Libner & Sons	7.78	9.19	18.88	19.00	5.35	6.00	52.92	5.88	5.00
955	*Quaker Ful-O-Pep Scratch Grains.* Quaker Oats Co., Chicago, Ill.	*Hamden:* Ira W. Beers	12.30	1.68	10.50	9.00	3.00	3.50	69.22	3.30	2.00
1083	*Schumacher's Little Chick Feed, No Grit.* Quaker Oats Co., Chicago, Ill.	*Devon:* Devon Coal & Ice Co. ..	11.38	1.62	10.19	10.00	2.28	2.00	71.59	2.94	2.00
1095	*Schumacher's Scratch Grains, No Grit.* Quaker Oats Co., Chicago, Ill.	*Danbury:* C. S. Barnum & Son ..	11.55	1.59	10.25	10.00	2.45	3.50	71.41	2.75	2.00
934	*Purina Baby Chick Chow Feed.* Ralston Purina Co., St. Louis, Mo.	*Meriden:* H. Grulich	11.50	1.61	10.63	10.00	2.13	4.00	71.28	2.85	2.00
2653	*Purina Chicken Chowder Feed containing Mineral.* Ralston Purina Co., St. Louis, Mo. ...	*Meriden:* H. Grulich	9.80	11.25	21.00	19.00	6.68	8.00	46.59	4.68	3.50
2907	*Purina Chicken Fat Chow Feed containing Mineral.* Ralston Purina Co., St. Louis, Mo. ...	*Stamford:* Clapboard Hill Feed Co.	10.25	4.40	16.19	15.50	3.95	5.00	61.36	3.85	3.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Water	Ash	Protein (N x 6.25) Found	Protein Guaranteed, not less than	Fiber Found	Fiber Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat Found	Fat Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Poultry Feeds—Continued		%	%	%	%	%	%	%	%	%
2566	*Purina Chicken Fatena Feed containing Mineral.* Ralston Purina Co., St. Louis, Mo.	*Stratford:* Farmers' Flour & Grain Co.	10.38	4.58	12.44	12.00	6.25	6.60	62.20	4.15	3.00
932	*Purina Chick Growena Feed containing Mineral.* Ralston Purina Co., St. Louis, Mo.	*Meriden:* H. Grulich	8.78	8.33	17.19	16.30	6.15	7.00	54.55	5.00	4.00
931	*Purina Chick Startena Feed containing Mineral.* Ralston Purina Co., St. Louis, Mo.	*Meriden:* H. Grulich	8.35	9.56	19.94	19.00	5.53	7.00	50.79	5.83	4.00
2806	*Purina Hen Chow Feed.* Ralston Purina Co., St. Louis, Mo.	*Manchester:* Manchester Grain Co.	12.05	1.71	10.13	10.00	2.88	4.00	69.88	3.35	2.50
933	*Purina Intermediate Hen Chow Feed.* Ralston Purina Co., St. Louis, Mo.	*Meriden:* H. Grulich	11.78	1.35	10.00	10.00	1.90	4.00	72.17	2.80	2.50
2496	*Purina Lay Chow Feed containing Mineral.* Ralston Purina Co., St. Louis, Mo.	*New London:* New London Grain Co.	10.43	10.85	17.19	17.00	7.73	8.00	49.85	3.95	2.50

2869	*Winner Scratch Feed.* Ralston Purina Co., St. Louis, Mo. ...	*Danbury:* H. E. Meeker	11.53	1.53	10.38	9.50	2.58	4.00	70.73	3.25	2.00
2431	*Diamond Intermediate Chick Feed.* Rockville Grain & Coal Co., Rockville	*Manchester:* Manchester Grain Co.	13.13	1.70	10.75	10.00	1.75	3.00	68.99	3.68	3.00
2432	*Diamond Scratch Feed.* Rockville Grain & Coal Co., Rockville ..	*Manchester:* Manchester Grain Co.	13.93	1.56	9.63	10.00	2.58	4.00	70.40	1.90	2.50
1117	*Hubbard's Egg Producer.* F. H. Rolf, Inc., Guilford	*Guilford:* F. H. Rolf, Inc.	8.73	13.38	24.69	22.00	5.49	5.00	42.61	5.10	4.00
1327	*Rolf's Chic Grains.* F. H. Rolf, Inc., Guilford	*Guilford:* F. H. Rolf, Inc.	13.80	1.42	9.81	10.00	1.80	4.00	69.92	3.25	4.00
1116	*Rolf's Chic Mash.* F. H. Rolf, Inc., Guilford	*Guilford:* F. H. Rolf, Inc.	7.93	13.96	19.31	17.00	4.85	6.00	49.30	4.65	3.00
1328	*Rolf's Scratch Grains.* F. H. Rolf, Inc., Guilford	*Guilford:* F. H. Rolf, Inc.	13.40	1.76	10.63	9.00	3.24	4.00	67.12	3.85	3.00
1401	*Atlas Poultry Greens.* A. W. Scott & Co., San Francisco, Cal.	*Wallingford:* A. E. Hall	7.75	10.03	17.88	20.00	23.33	18.00	38.93	2.08	2.00
1159	*See-More Egg Mash Buttermilk.* Seymour Grain & Coal Co., Seymour	*Seymour:* Seymour Grain & Coal Co.	9.43	11.81	18.88	18.00	5.18	7.00	50.17	4.53	4.50
1160	*See-More Egg Scratch Feed.* Seymour Grain & Coal Co., Seymour	*Seymour:* Seymour Grain & Coal Co.	12.48	1.58	10.31	10.00	3.08	6.00	69.42	3.13	3.00
1068	*Nelson's Laying Mash.* Shelton Feed Co., Shelton	*Shelton:* Shelton Feed Co.	10.63	7.38	17.19	16.00	7.40	8.00	52.47	4.93	4.00
1067	*Nelson's Mixed Chicken Feed.* Shelton Feed Co., Shelton	*Shelton:* Shelton Feed Co.	13.23	1.62	10.00	10.00	2.58	5.00	69.47	3.10	1.50
1144	*Mill Streams "Fortune Hunter" Scratch Grains.* Winchell Smith Grist Mill, Farmington	*Farmington:* Winchell Smith Grist Mill	12.85	1.91	10.38	10.00	3.15	3.00	67.83	3.88	2.50
1143	*Mill Streams "Lightnin" Laying Mash.* Winchell Smith Grist Mill, Farmington	*Farmington:* Winchell Smith Grist Mill	10.35	10.10	20.50	16.00	5.33	8.00	49.38	4.29	3.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred: Water	Ash	Protein (N x 6.25): Found	Protein: Guaranteed, not less than	Fiber: Found	Fiber: Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat: Found	Fat: Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Poultry Feeds—Continued		%	%	%	%	%	%	%	%	%
2582	*Ansonia Egg Mash, with Buttermilk.* I. Sovitsky Grain & Coal Co., Ansonia	*Ansonia:* I. Sovitsky Grain & Coal Co.	10.28	10.20	20.00	18.69	5.53	5.70	48.29	5.70	6.61
2993	*Ansonia Egg Mash, with Buttermilk.* I. Sovitsky Grain & Coal Co., Ansonia	*Ansonia:* I. Sovitsky Grain & Coal Co.	9.30	8.83	19.38	18.69	6.20	5.70	49.99	6.30	6.61
2742	*Ansonia Scratch Feed.* I. Sovitsky Grain & Coal Co., Ansonia	*Ansonia:* I. Sovitsky Grain & Coal Co.	11.48	1.63	10.75	10.63	2.85	2.72	70.56	2.73	2.29
1165	*King Baby Chick Food (containing Cod Liver Meal, Buttermilk).* St. Albans Grain Co., St. Albans, Vt.	*Willimantic:* Willimantic Grain Co.	10.85	6.29	17.81	16.50	3.58	5.00	57.47	4.00	4.00
1164	*King Chick Feed.* St. Albans Grain Co., St. Albans, Vt.	*Willimantic:* Willimantic Grain Co.	12.80	1.51	10.38	10.00	1.40	4.00	71.43	2.48	2.50
1169	*King Growing Feed (containing Buttermilk).* St. Albans Grain Co., St. Albans, Vt.	*Willimantic:* Willimantic Grain Co.	10.75	7.77	17.06	15.00	5.88	5.00	51.99	6.55	4.00

1166	*King Intermediate Chick Feed.* St. Albans Grain Co., St. Albans, Vt.	*Willimantic:* Willimantic Grain Co.	12.50	1.40	10.19	10.00	1.79	3.50	71.12	3.00	2.50
1170	*King Mash Feed (containing Buttermilk).* St. Albans Grain Co., St. Albans, Vt.	*Willimantic:* Willimantic Grain Co.	10.85	9.57	19.06	19.50	5.54	7.50	50.78	4.20	4.00
1190	*King Scratch Feed.* St. Albans Grain Co., St. Albans, Vt.	*Norwich:* Norwich Grain Co.	13.60	1.62	10.56	10.00	2.74	5.50	68.88	2.60	2.50
2640	*Paragon Scratch Feed. St. Albans Grain Co.*, St. Albans, Vt.	*Meriden:* H. Grulich	12.20	1.83	10.50	10.00	2.83	5.00	69.89	2.75	2.50
926	*Wirthmore All Grain Chick Feed (Fine Chick Scratch).* St. Albans Grain Co., St. Albans, Vt.	*Plantsville:* C. A. Cowles	12.18	1.39	10.44	10.00	1.68	3.50	71.81	2.50	2.50
925	*Wirthmore Baby Chick Starter (containing Cod Liver Meal-Buttermilk).* St. Albans Grain Co., St. Albans, Vt.	*Plantsville:* C. A. Cowles	10.88	6.23	16.75	17.00	3.63	5.00	58.36	4.15	4.00
1053	*Wirthmore Growing Feed (containing Buttermilk).* St. Albans Grain Co., St. Albans, Vt.	*Branford:* S. V. Osborn Est.	9.25	10.69	17.50	15.00	5.90	5.00	51.68	4.98	4.50
2449	*Wirthmore Growing Feed (containing Buttermilk).* St. Albans Grain Co., St. Albans, Vt.	*East Haven:* F. A. Forbes	11.68	8.37	16.25	15.00	5.30	5.00	53.67	4.73	4.50
924	*Wirthmore Intermediate Chick (Coarse Chick Scratch).* St. Albans Grain Co., St. Albans, Vt.	*Hamden:* Ira W. Beers	12.33	1.68	11.00	10.00	2.03	3.50	69.69	3.27	2.50
1051	*Wirthmore Laying Mash (containing Buttermilk).* St. Albans Grain Co., St. Albans, Vt.	*Guilford:* Fred C. Morse & Son	8.53	10.22	20.31	20.00	5.53	7.00	49.93	5.48	4.00
923	*Wirthmore Scratch Feed.* St. Albans Grain Co., St. Albans, Vt.	*Hamden:* Ira W. Beers	13.38	1.71	11.25	10.00	2.43	4.00	68.68	2.55	2.50

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
			Water	Ash	Protein (N x 6.25)		Fiber		Nitrogen-free extract (starch, gum, etc.)	Fat	
					Found	Guaranteed, not less than	Found	Guaranteed, not more than		Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Poultry Feeds—Continued										
			%	%	%	%	%	%	%	%	%
2637	*Wirthmore Turkey Starter (containing Cod Liver Oil-Buttermilk).* St. Albans Grain Co., St. Albans, Vt.	*Naugatuck:* Naugatuck Fruit & Produce Co.	10.53	8.35	18.19	17.00	3.43	5.00	55.10	4.40	4.00
2890	*Symco Scratch Grains.* Syracuse Milling Co., Syracuse, N. Y.	*East Bridgeport:* J. Simon	11.50	1.68	10.25	9.00	3.18	10.00	70.26	3.13	2.50
1217	*Syragold Chick Feed.* Syracuse Milling Co., Syracuse, N. Y.	*Colchester:* P. Cutler, Inc.	12.83	1.82	11.69	10.00	2.19	5.00	68.44	3.03	2.50
1104	*Syragold Chick Starter.* Syracuse Milling Co., Syracuse, N. Y.	*East Bridgeport:* J. Simon	10.65	8.68	18.50	18.00	2.53	4.00	55.01	4.63	3.50
2897	*Syragold Egg Mash.* Syracuse Milling Co., Syracuse, N. Y.	*Southport:* C. Buckingham & Co.	9.90	7.94	18.63	18.00	6.68	8.00	51.70	5.15	3.00
1105	*Syragold Growing Mash.* Syracuse Milling Co., Syracuse, N. Y.	*Southport:* C. Buckingham & Co.	9.95	10.15	17.13	16.00	3.40	7.00	54.67	4.70	4.00

1103	*Syragold Laying Mash, with Buttermilk.* Syracuse Milling Co., Syracuse, N. Y.	*East Bridgeport:* J. Simon	9.65	11.23	18.31	18.00	8.63	9.00	46.98	5.20	3.00
1106	*Syragold Scratch Grains.* Syracuse Milling Co., Syracuse, N. Y.	*Southport:* C. Buckingham & Co.	12.50	1.59	9.75	10.00	2.55	5.00	70.89	2.72	2.50
1128	*Thomaston Egg Mash.* Thomaston Supply Co., Thomaston ..	*Thomaston:* Thomaston Supply Co.	9.23	14.23	17.94	20.00	6.68	7.00	47.39	4.53	4.50
1129	*Thomaston Scratch Feed.* Thomaston Supply Co., Thomaston	*Thomaston:* Thomaston Supply Co.	12.73	1.68	10.13	10.00	3.40	5.00	69.11	2.95	3.00
2852	*Chicatine.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Hawleyville:* W. A. Honan, Inc.	10.10	7.58	22.88	18.00	3.85	6.00	50.26	5.33	3.00
2853	*Egatine.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Hawleyville:* W. A. Honan, Inc.	9.90	8.15	24.75	23.00	4.95	6.00	46.95	5.30	2.50
2879	*Derby E Gee Scratch Feed.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Collinsville:* Lawton-Miner Co.,	12.48	1.65	10.19	9.00	2.88	4.50	70.27	2.53	2.04
2855	*Tioga Chick and Growing Mash.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Hawleyville:* W. A. Honan, Inc.	10.95	5.76	16.56	12.00	4.75	6.00	57.00	4.98	2.00
2854	*Tioga Laying Food.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Hawleyville:* W. A. Honan, Inc.	9.50	7.15	20.25	17.00	5.75	6.00	51.65	5.70	2.50
2844	*Tioga Neverfail Chick Grains.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Torrington:* Litchfield Co-op. Assoc.	11.43	1.18	10.25	10.00	1.05	3.50	72.81	3.28	3.00
2856	*Tioga Neverfail Growing Grains.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Hawleyville:* W. A. Honan, Inc.	11.78	1.38	10.31	10.00	1.60	4.00	71.78	3.15	2.50
2838	*Tioga Neverfail Poultry Grain.* Tioga-Empire Feed Mills, Waverly, N. Y.	*Torrington:* Litchfield Co-op. Assoc.	11.88	1.55	10.00	9.00	3.05	4.79	70.99	2.53	2.08

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
			Water	Ash	Protein (N x 6.25)		Fiber		Nitrogen-free extract (starch, gum, etc.)	Fat	
					Found	Guaranteed, not less than	Found	Guaranteed, not more than		Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Poultry Feeds—Concluded		%	%	%	%	%	%	%	%	%
2531	*Ubiko All Mash Complete Laying Ration.* Ubiko Milling Co., Cincinnati, Ohio	*Lebanon:* Berkman Grain Co. ..	9.13	7.85	17.69	16.00	5.03	6.00	55.07	5.23	3.50
2600	*Ubiko All Mash Developer.* Ubiko Milling Co., Cincinnati, Ohio	*Lebanon:* Berkman Grain Co. ..	10.18	6.45	16.31	14.00	4.43	5.00	58.18	4.45	4.00
1005	*Vitality Egg Mash.* Vitality Mills, Inc., Chicago, Ill.	*Meriden:* Raymond Ives	9.38	13.36	19.19	20.00	5.65	8.00	46.49	5.93	4.00
1007	*Vitality Scratch Feed (No Grit).* Vitality Mills, Inc., Chicago, Ill.	*Meriden:* Raymond Ives	12.30	1.89	11.06	10.00	2.78	5.00	68.84	3.13	2.50
938	*Wayne All Mash Chick Starter.* Wayne Feed Mills, Fort Wayne, Ind.	*New Britain:* New Britain Bird Store	10.03	6.72	17.50	16.00	5.05	6.00	55.65	5.05	4.00
852	*Wayne Egg Mash.* Wayne Feed Mills, Fort Wayne, Ind.	*New Britain:* New Britain Bird Store	7.25	8.80	18.00	18.00	5.68	7.00	55.24	5.03	3.50

1008	*Wayne Scratch Feed.* Wayne Feed Mills, Fort Wayne, Ind.	*New Britain:* New Britain Bird Store	11.25	1.66	9.81	10.00	2.88	5.00	70.50	3.90	3.00
2824	*Big (Y) Growing Feed.* Yantic Grain & Products Co., Norwich	*Mystic:* Mystic Grain Co.	9.15	10.21	17.50	16.00	6.28	6.00	52.13	4.73	4.00
1171	*Big (Y) Laying Mash.* Yantic Grain & Products Co., Norwich	*Willimantic:* Boston Grain Co.	10.68	8.64	17.00	16.00	5.84	7.00	53.26	4.58	4.00
1191	*Big (Y) Laying Mash, with Buttermilk.* Yantic Grain & Products Co., Norwich	*Norwich:* Yantic Grain & Products Co.	11.88	8.57	19.25	16.00	5.47	7.00	50.08	4.75	4.00
2826	*Big (Y) Scratch Feed.* Yantic Grain & Products Co., Norwich	*Mystic:* Mystic Grain Co.	11.98	1.64	10.56	10.00	3.32	5.00	69.85	2.65	3.00
1275	*Gingh'm Gal Scratch Feed.* Yantic Grain & Products Co., Norwich	*New London:* New London Grain Co.	13.93	1.65	10.63	10.00	3.25	5.00	68.36	2.18	3.00
	Beef Scraps, etc.										
2908	*"Capitol Meat & Bone Scrap."* American Agricultural Chemical Co., N. Y.	*Springdale:* Springdale Coal & Ice Co.	7.50	28.03	48.13	45.00	2.15	3.00	4.69	9.50	3.00
1167	*Atco Brand Fish Meal.* Atlantic Coast Fisheries Co., N. Y.	*Willimantic:* Willimantic Grain Co.	8.36	22.22	67.19	65.00	0.43	0.50	....	1.80	0.50
1081	*Buell-Boston Dried Skim Milk.* C. E. Buell, Inc., Boston, Mass.	*Danbury:* C. S. Barnum & Son	4.85	8.01	34.63	31.00	....	....	51.61	0.90	0.20
962	*Burch Brand Powdered Skim Milk.* C. W. Burckhalter, New York City	*Wallingford:* A. E. Hall	6.90	8.44	34.00	32.00	....	....	49.78	0.88	0.75
1168	*Collis Process Pure Dried Skim Milk.* Collis Products Co., Clinton, Iowa	*Willimantic:* Willimantic Grain Co.	7.35	8.04	34.38	30.00	....	....	49.23	1.00	1.00
2508	*Collis Dried Buttermilk.* Collis Products Co., Clinton, Iowa	*Mystic:* Mystic Grain Co.	10.38	10.33	30.13	30.00	....	....	42.11	7.05	5.00

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Continued*

Station No.	Manufacturer and Brand	Retail Dealer	Pounds per Hundred								
			Water	Ash	Protein (N x 6.25)		Fiber		Nitrogen-free extract (starch, gum, etc.)	Fat	
					Found	Guaranteed, not less than	Found	Guaranteed, *not more* than		Found	Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Continued*										
	Beef Scraps, etc.—Continued										
			%	%	%	%	%	%	%	%	%
1002	*Meat Scrap for Poultry.* Conn. Fat Rendering & Fertilizer Corp., New Haven	*Hamden:* Ira W. Beers	7.68	28.61	49.88	45.00	....	....	2.85	10.98	10.00
1326	*Consolidated Bone Meal.* Consolidated By-Products Co., Philadelphia, Pa.	*Norwich:* A. E. Shedd	3.88	72.05	14.50	10.00	0.95	2.00	3.17	5.45	5.00
2557	*Corenco Bone Meal, An All Animal Feed for Cattle, Hogs & Poultry.* Consolidated Rendering Co., Boston, Mass.	*West Cheshire:* Cheshire Grain & Coal Co.	7.68	65.20	23.94	20.00	....	....	2.83	0.35	3.00
2984	*Corenco Bone Meal, An All Animal Feed for Cattle, Hogs & Poultry.* Consolidated Rendering Co., Boston, Mass.	*West Cheshire:* Cheshire Grain & Coal Co.	7.53	66.70	24.13	20.00	....	....	1.39	0.25	3.00
2763	*Chikora.* Dry Milk Co., N. Y.	*Guilford:* Fred C. Morse & Son	5.35	8.10	36.06	35.14	....	....	49.39	1.10	1.00

2690	*Pure Dried Skim Milk Powder.* Eastern Grain Co., Bridgewater, Mass.	*New Britain:* C. W. Lines Co.	5.90	7.85	34.38	32.00	....	....	51.04	0.83	0.75
2858	*Butterfly Brand Dried Skimmilk.* S. T. Edwards & Co., Chicago, Ill.	*Winsted:* E. Manchester & Sons	6.53	7.50	35.19	32.00	....	....	49.83	0.95	0.25
2479	*Yankee Dried Buttermilk.* S. T. Edwards & Co., Chicago, Ill.	*Guilford:* Fred C. Morse & Son	6.75	7.85	33.75	32.00	....	....	50.02	1.63	4.00[1]
2929	*Yankee Dried Buttermilk.* S. T. Edwards & Co., Chicago, Ill.	*Guilford:* Fred C. Morse & Son	6.43	7.72	33.63	32.00	....	....	50.57	1.65[1]	4.00[1]
1015	*Fairmont's Better Pure Flake Buttermilk.* Fairmont Creamery Co., Omaha, Neb.	*Thompsonville:* Geo. S. Phelps & Co.	7.85	13.95	27.88	32.00	....	....	40.89	9.43	6.00
2628	*Frisbie's Poultry Feed.* L. T. Frisbie Co., New Haven	*Westville:* R. G. Davis & Sons	6.13	36.18	44.50	45.00	....	....	3.31	9.88	8.00
1130	*Frisbie's Poultry Feed.* L. T. Frisbie Co., New Haven	*Thomaston:* Thomaston Supply Co.	5.45	29.80	52.00	50.00	....	....	4.63	8.12	8.00
2791	*Frisbie's Poultry Feed.* L. T. Frisbie Co., New Haven	*Bloomfield:* Bloomfield Farmers' Exchange	6.25	28.21	53.63	55.00	....	....	2.13	9.78	8.00
960	*Gorton's Codfish Meal.* Gorton-Pew Fisheries Co., Gloucester, Mass.	*Plantsville:* C. A. Cowles	6.28	38.63	52.06	55.00	....	....	2.08	0.95	0.10
2753	*Gorton's Codfish Meal.* Gorton-Pew Fisheries Co., Gloucester, Mass.	*Thomaston:* Thomaston Supply Co.	4.80	36.10	56.13	55.00	1.53	1.00	0.31	1.13	0.10
2146	*Edible Bone.* Hafleigh & Company, Philadelphia, Pa.	*Norwich:* Norwich Grain Co.	6.92	67.39	23.06	....	....	....	0.22	2.41	....
2964	*Land O'Lakes Dried Skim Milk.* Land O'Lakes Creameries, Inc., Minneapolis, Minn.	*West Cheshire:* Cheshire Grain & Coal Co.	6.53	8.20	34.00	30.00	....	....	49.64	1.63	0.50

[1] Roese-Gottlieb Method.

TABLE I. ANALYSES OF COMMERCIAL FEEDS, INSPECTION OF 1929—*Concluded*

Station No.	Manufacturer and Brand	Retail Dealer	Water	Ash	Protein (N x 6.25) Found	Protein Guaranteed, not less than	Fiber Found	Fiber Guaranteed, not more than	Nitrogen-free extract (starch, gum, etc.)	Fat Found	Fat Guaranteed, not less than
	PROPRIETARY MIXED FEEDS—*Concluded*										
	Beef Scraps, etc.—Concluded		%	%	%	%	%	%	%	%	%
2808	*Cooked Meat & Bone Scrap.* A. G. Markham & Co., Springfield, Mass.	*Stafford Springs:* Dennis Grain Mill	7.33	25.74	55.88	50.00	....	....	2.22	8.83	8.00
2882	*Marsh's Pure Ground Scraps for Poultry.* Geo. E. Marsh Co., Lynn, Mass.	*Hawleyville:* W. A. Honan, Inc.	5.43	34.25	41.25	40.00	....	....	6.62	12.45	8.00
2632	*Morse's Meat Scraps.* Jas. F. Morse & Co., Somerville, Mass.	*Seymour:* Seymour Grain & Coal Co.	6.25	36.75	41.00	40.00	....	....	7.60	8.40	8.00
2670	*Blue Seal Meat Scraps.* N. E. By-Products Corp., Lawrence, Mass.	*Plantsville:* C. A. Cowles	6.70	32.03	46.75	50.00	1.58	3.00	2.21	10.73	5.00
2987	*Blue Seal Meat Scraps.* N. E. By-Products Corp., Lawrence, Mass.	*Plantsville:* C. A. Cowles	6.28	30.28	48.00	50.00	1.48	3.00	1.66	12.30	5.00
2748	*White Seal Meat Scraps.* N. E. By-Products Corp., Lawrence, Mass.	*Watertown:* Watertown Co-operative Assoc.	5.73	43.49	39.63	40.00	1.28	4.00	1.59	8.28	5.00

2510	*Register Brand Meat Scrap.* John Reardon & Sons Co., Cambridge, Mass.	*Westerly:* C. W. Campbell Co.	5.20	35.40	44.63	45.00	1.70	3.00	2.07	11.00	6.00
2509	*Register Brand Meat Scrap.* John Reardon & Sons Co., Cambridge, Mass.	*Westerly:* C. W. Campbell Co.	5.50	28.90	54.25	55.00	1.60	3.00	1.45	8.30	6.00
2813	*Edible Bone Flour for Cattle & Poultry.* The Rogers & Hubbard Co., Portland	*Willimantic:* Willimantic Grain Co.	8.55	67.03	24.00	23.85	....	....	0.12	0.30	0.25
2527	*Edible Steamed Bone.* The Rogers & Hubbard Co., Portland	*Norwich:* Norwich Grain Co.	3.75	85.70	5.81	5.00	....	....	4.41	0.33	....
1110	*Chic-Chuck "The Ideal Concentrated Poultry Food."* Russia Cement Co., Gloucester, Mass.	*Seymour:* Seymour Grain & Coal Co.	4.83	35.51	53.31	45.00	1.69	1.00	3.53	1.13	0.10
2237	*Shoemaker's "Swift-Sure" 50% Meat & Bone Scrap.* M. L. Shoemaker & Co., Philadelphia, Pa.	*New Milford:* Geo. T. Soule	6.13	28.46	48.38	50.00	1.74	3.00	1.76	13.53	6.00
2597	*Slugg's Dried Skim Milk.* W. G. Slugg, Milwaukee, Wis.	*Guilford:* F. H. Rolf, Inc.	6.98	8.78	34.56	30.00	....	....	48.90	0.78	0.50
2707	*Springfield Poultry Feed.* Springfield Rendering Co., Springfield, Mass.	*Hazardville:* A. D. Bridge's Sons	6.63	36.35	45.63	45.00	....	....	3.26	8.13	8.00
1112	*Stanley's Meat & Bone Scrap.* John T. Stanley Co., New York City	*Danbury:* C. S. Barnum & Son	7.28	29.58	46.31	45.00	1.77	3.00	5.01	10.05	10.00
935	*Struven's Fish Meal.* Chas. M. Struven & Co., Baltimore, Md.	*Wallingford:* A. E. Hall	9.78	21.26	57.19	55.00	0.68	2.00	4.26	6.83	4.00
2812	*P. W. Meat Scraps.* Worcester Rendering Co., Auburn, Mass.	*Willimantic:* Willimantic Grain Co.	6.10	30.21	48.50	45.00	1.45	6.00	2.81	10.93	8.00
2526	*P. W. Special Meat Scrap.* Worcester Rendering Co., Auburn, Mass.	*Norwich:* Norwich Grain Co.	7.80	24.73	56.25	55.00	1.90	5.00	0.59	8.73	8.00

TABLE II. ANALYSES OF FEEDS SUBMITTED BY INDIVIDUALS

Station No.	Material	Submitted by	Pounds per Hundred: Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen-free extract (starch, gum, etc.)	Ether extract (Crude fat)
	Dairy Feeds		%	%	%	%	%	%
1858	Dairy Ration	*New Haven:* Ambrose Allen	8.55	7.38	19.50	10.48	49.12	4.97
1020	Eastern States Full Pail 20%	*Wallingford:* Barnes & Co.	7.93	7.01	20.50	7.73	52.25	4.58
1021	20% Open Formula Feed A	*Wallingford:* Barnes & Co.	7.83	5.18	20.63	8.10	52.83	5.43
1022	20% Open Formula Feed B	*Wallingford:* Barnes & Co.	8.83	7.25	20.06	7.70	51.68	4.48
2937	Dairy Feed	*Litchfield:* Harry Borgeson	8.50	5.68	21.75	8.93	51.01	4.13
1683	Basic Dairy Ration No. 2	*Clintonville:* John Carlson	11.80	7.74	19.56	7.48	48.78	4.64
3127	Syragold 24% Dairy Ration	*New Canaan:* Clapboard Hill Co., Inc.	....	....	23.13	10.80	....	5.23
9919	Dairy Ration	*Middletown:* The Coles Co.	8.77	6.20	19.50	7.40	53.26	4.87
9871	Dairy Feed	*Meriden:* Grulich & Son	10.16	....	25.75	9.30	....	3.74
2960	Dairy Feed	*Wallingford:* Laden Bros.	9.35	6.44	21.31	9.15	48.92	4.83
872	Dairy Ration	*Middlefield:* The Lyman Farm	9.63	8.18	17.63	11.03	49.00	4.53
2180	Dairy Ration	*Hartford:* New York Feed & Grain Co.	8.81	7.08	21.88	9.40	47.95	4.88
2918	Paragon Dairy Feed	*Stepney Depot:* Nusbaum's Feed Store	7.83	8.15	23.06	10.10	46.21	4.65
2822	Dairy Mixture, Sample No. 1	*Southbury:* H. R. Stone	9.85	7.15	23.75	7.73	46.97	4.55
2823	Special Sample No. 2	*Southbury:* H. R. Stone	9.55	7.60	20.00	11.73	46.47	4.65

1731	20% Dairy Feed	*Ansonia:* I. Sovitsky Grain & Coal Co.	8.33	8.15	19.13	10.14	49.45	4.80
2025	Dairy Feed 20%	*Ansonia:* I. Sovitsky Grain & Coal Co.	8.47	8.15	19.88	9.70	47.90	5.90
2110	Ansonia Dairy Feed 20%	*Ansonia:* I. Sovitsky Grain & Coal Co.	9.42	7.40	19.88	9.99	48.78	4.53
2026	Ansonia Stock Feed	*Ansonia:* I. Sovitsky Grain & Coal Co.	9.19	4.95	9.56	10.39	61.24	4.67
662	Big (Y) Dairy Ration	*Norwich:* Yantic Grain & Products Co.	7.58	8.13	24.63	7.50	47.11	5.05
819	Big (Y) Dairy Ration	*Norwich:* Yantic Grain & Products Co.	8.13	9.43	23.00	7.63	47.63	4.18
3158	Abington Dairy Feed	*Norwich:* Yantic Grain & Products Co.	7.13	....	22.00	12.15	....	3.95
	Horse Feeds							
515	Alfalfa Leaf Meal	*Glastonbury:* B. O. Bailey	7.23	15.31	17.38	13.03	44.35	2.70
9920	California Leaf Meal	*Norwich:* Yantic Grain & Products Co.	6.71	18.31	19.75	17.08	36.16	1.99
3139	Pulverized Oats	*Norwich:* Yantic Grain & Products Co.	7.48	....	13.50	14.25	....	5.20
	Poultry Feeds							
8179	Mash No. 1	*West Cheshire:* Cheshire Grain & Coal Co.	7.05	8.89	17.75	5.68	55.93	4.70
8180	Mash No 2	*West Cheshire:* Cheshire Grain & Coal Co.	6.80	7.02	17.38	6.08	57.39	5.33
8472	Dry Mash A	*Middletown:* The Coles Co.	6.33	9.49	16.75	6.53	56.32	4.58
8473	Dry Mash B	*Middletown:* The Coles Co.	6.25	8.84	18.25	6.13	55.75	4.78
2891	Edible Steamed Bone	*New Haven:* R. G. Davis & Sons	....	87.03	5.56	....	....	0.23
2732	Mash No. 1	*Windsor:* L. W. Hudson	9.28	9.78	22.44	5.73	49.17	3.60
2733	Mash No. 12	*Windsor:* L. W. Hudson	9.93	10.83	22.06	3.93	49.50	3.75
2961	Growing Feed	*Wallingford:* Laden Bros.	9.68	6.65	17.06	4.33	56.88	5.40
2962	Laying Mash	*Wallingford:* Laden Bros.	9.40	5.86	17.13	4.80	56.78	6.03
1594	Mash No. 1	*South Coventry:* E. W. Latimer	7.88	9.75	16.50	7.15	56.02	2.70
1595	Mash No. 2	*South Coventry:* E. W. Latimer	8.06	9.75	17.25	5.57	55.66	3.71
8901	Mash A	*Guilford:* Fred C. Morse & Son	11.05	....	17.38	5.80	....	4.70

TABLE II. ANALYSES OF FEEDS SUBMITTED BY INDIVIDUALS—*Concluded*

Station No.	Material	Submitted by	Pounds per Hundred					
			Water	Ash	Protein (N x 6.25)	Fiber	Nitrogen free extract (starch, gum, etc.)	Ether extract (Crude fat)
			%	%	%	%	%	%
	Poultry Feeds—Concluded							
8902	Mash B	*Guilford:* Fred C. Morse & Son	11.05	....	16.50	5.55	....	3.25
1532	Starting Mash	*Thomaston:* Mary Pfundt	9.13	11.14	16.69	6.30	51.61	5.13
9005	Laying Mash	*Meriden:* Reliable Grain & Feed Co.	8.06	....	19.19	6.74	....	2.70
1730	Scratch Grains	*Ansonia:* I. Sovitsky Grain & Coal Co.	11.10	2.36	10.63	2.72	70.90	2.29
1732	Mash	*Ansonia:* I. Sovitsky Grain & Coal Co.	9.93	10.15	15.19	5.55	55.77	3.41
2027	Buttermilk Egg Mash	*Ansonia:* I. Sovitsky Grain & Coal Co.	10.10	7.79	18.69	5.70	51.11	6.61
	Maize Products							
305	Gluten Feed A	*Middletown:* The Coles Co.	7.55	7.23	26.50	7.95	48.22	2.55
306	Gluten Feed B	*Middletown:* The Coles Co.	7.58	8.36	27.06	8.08	45.69	3.23
2309	Corn Meal No. 1	*Kensington:* S. F. Labieniec	13.45	....	....	....	....	....
2310	Corn Meal No. 2	*Kensington:* S. F. Labieniec	14.04	....	....	....	....	....
8842	Whole Corn	*Norwalk:* Frank Libner & Sons	10.20	....	....	....	....	....
8843	Cracked Corn	*Norwalk:* Frank Libner & Sons	9.85	....	....	....	....	....
1911	Corn Flakes	*Meriden:* William S. O'Brien	9.69	0.53	9.00	0.46	79.67	0.65
	Miscellaneous							
2343	Bread Meal	*Storrs:* A. R. Merrill	11.48	2.43	12.19	0.57	69.42	3.91
3128	Calf Meal No. 1	*Chester:* Leet Bros.	....	....	24.50	2.53	....	5.90

	Miscellaneous—Concluded							
3129	Calf Meal No. 2	*Chester:* Leet Bros.	....	....	20.19	3.40	....	7.45
2730	Cod Liver Meal	*Stafford Springs:* Dennis Grist Mills	8.08	10.68	56.25	3.53	3.28	18.18
2461	Corn Distillers' Grains	*Guilford:* Fred C. Morse & Son	6.65	2.26	25.25	12.38	43.81	9.65
9007	Corn Distillers' Grains	*Norwich:* Yantic Grain & Products Co.	5.15	....	25.50	13.80	....	8.93
1487	Feed	*Middletown:* Henry F. Brock	6.78	10.63	20.44	5.48	51.04	5.63
3168	Feed A	*Westport:* Samuel S. Daskam	7.68	....	25.25	9.00	....	4.53
3169	Feed B	*Westport:* Samuel S. Daskam	8.30	....	18.50	8.25	....	4.85
8264	Feed	*South Norwalk:* Roodner Feed Co., Inc.	4.13	4.84	9.06	12.00	65.59	4.38
9270	Feed No. 2	*Middletown:* John Robb	8.63	....	24.19	7.98	....	4.65
9269	Feed No. 1	*Middletown:* John Robb	8.75	....	24.56	8.43	....	4.45
341	Feed	*Southbury:* H. R. Stone	8.15	7.12	23.19	7.98	48.71	4.85
568	Feed No. C	*Wesleyan University:* Prof. Hoover	6.95	....	23.81	....	....	....
567	Feed No. B	*Wesleyan University:* Prof. Hoover	8.53	....	19.75	....	....	....
566	*Feed No. A*	*Wesleyan University:* Prof. Hoover	7.05	....	15.81	....	....	....
663	Dealer's Mixing Feed with Molasses	*Watertown:* Watertown Co-op. Assoc., Inc.	7.93	5.61	11.38	8.65	60.38	6.05
664	Hi-Test Mixing Feed	*Watertown:* Watertown Co-op. Assoc., Inc.	9.38	5.04	10.75	10.68	61.12	3.03
676	Feed	*Portland:* S. E. Frisbie	9.75	8.45	20.25	6.65	51.05	3.85
1172	Feed	*Stepney Depot:* Nusbaum's Feed Store	6.43	7.34	22.00	10.88	48.65	4.70
1218	Buckwheat Feed	*Guilford:* Fred C. Morse & Son	9.33	2.58	13.13	17.71	54.52	2.73
1365	Feed	*Norwich:* Walter T. Clark	....	....	20.88	....	....	....
1434	Grain	*Storrs:* A. D. Pratt	8.65	6.50	21.13	7.71	51.55	4.46
2271	Feed No 2	*Wallingford:* Laden Bros.	10.13	....	16.56	5.83	....	6.25
2270	Feed No. 1	*Wallingford:* Laden Bros.	9.93	....	17.56	5.50	....	6.48
3144	Peanut Waste	*Wallingford:* Laden Bros	5.13	2.31	21.38	6.93	32.60	31.65
2462	Jersey Milk Food Compound	*Guilford:* Fred C. Morse & Son	10.65	6.11	17.25	1.88	60.06	4.05
2914	Pig Feed	*Salisbury:* D. J. Decker	....	....	20.13	....	....	....
2913	Cooked Wheat Middlings	*Bridgeport:* Wm. Snow	10.88	2.35	12.25	5.13	65.41	3.98
2912	Cooked Wheat Hulls—Bran	*Bridgeport:* Wm. Snow	9.35	2.86	11.00	10.43	62.61	3.75
9125	Rye Middlings Feed	*Colchester:* Red Wing Feed & Lumber Co.	8.00	....	16.94	4.45	....	2.55

MISCELLANEOUS MATERIALS

In addition to feed samples listed in Table II, which were submitted for the regular fodder analysis, 42 other samples were examined which for the most part require no particular comment.

Many of these were feeds suspected of having caused sickness or death of poultry. In such cases, unless conspicuous poisons can be detected, the probable cause of the trouble experienced cannot be determined. Although it is conceivable that some ingredient in the feed may be responsible, it is altogether more probable that the results were due to other causes. Thus, an instance came to our notice where a large portion of a flock of chicks died, the deaths beginning to occur at about the time a change of feed was made. This particular feed was replaced by another brand of similar type and at the time the suspected feed was submitted mortality in the flock had practically ceased. Under the circumstances suspicion attached rather strongly to the feed, but careful examination revealed nothing to justify or confirm that suspicion. *Bacteriological examination (made elsewhere) of the dead chicks* showed that the flock was infected with white diarrhea. This story is typical of many complaints that accompany samples of feed submitted, and while the explanation may not always be the same as in the instance cited, some other disease of an epidemic nature may be the cause.

Several samples of Fos-for-us poultry grits were submitted for determinations of fluorine. The manufacturers of this product point out that this is not ordinary rock phosphate, which may contain from 3 to 4 per cent of fluorine and from which unfavorable results due to fluorine have been noted in feeding experience. Fos-for-us is said to contain 70 per cent of calcium carbonate, 25 per cent of calcium phosphate, the balance being chiefly iron, sulfur and silica. Our examination of the samples submitted showed total calcium (CaO), ranging from 48.90 to 49.98 per cent; total phosphorus (P_2O_5), from 8.78 to 10.60 per cent; and fluorine (Fl.), from 0.1 to 0.25 per cent. So far as we can judge these small amounts of fluorine are not sufficient to give cause for suspicion or alarm.

Bulletin 318 May, 1930

REPORT OF THE DIRECTOR

For The Year Ending October 31, 1929

Connecticut

Agricultural Experiment Station

New Haven

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

Officers and Staff, As of October 31, 1929

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THE TUTTLE, MOREHOUSE & TAYLOR COMPANY, NEW HAVEN, CONN.

REPORT OF THE DIRECTOR

For the Year Ending October 31, 1929

To the Board of Control of the Connecticut Agricultural Experiment Station:

In discussing the events of the past year there comes to mind at once the death of Dr. Thomas B. Osborne whose outstanding work in biochemistry and nutrition brought fame and honor, not only to himself but to the Station where he spent his entire professional life. A memorial is now being prepared, to be published as a Station bulletin, in which we have tried to record our high regard for our fellow worker and friend. It will include certain unpublished papers of Dr. Osborne, a complete bibliography and a number of biographical and personal papers.

Mr. Charles R. Treat of Orange, for many years a member of the Board of Control and in recent years its vice-president, died in February. To the Station this was a great loss. Mr. Treat's interest in the work of the Station was always active, intelligent and helpful; his judgment was sound and his time freely given.

Each year brings new problems to the farmers of the state and many of these are passed on to the Station. The spread of the European Corn Borer, the Japanese Beetle, the Oriental Peach Moth and other insect pests has placed unusually heavy burdens upon us. The Peach Moth has become a major pest in many orchards and at the request of the growers we have undertaken an attack along the line that is now most promising, namely, the rearing and distribution of parasites. In September a fund was subscribed by the growers and a special allotment of $5,000 made by the State Board of Finance and Control. Work was begun immediately, involving the building and purchase of a large amount of equipment and the employment of two assistants. It is hoped that sufficient numbers of two parasites to bring about substantial control can be reared for release in peach orchards next June.

Other new enterprises are the inauguration of the plan to eradicate the black currant, an alternate host of the White Pine Blister Rust; the establishment of a field station at Windsor for the growing of forest planting stock, vegetable breeding and soil fertility studies. Mention should also be made of the enactment of a "pure seed law" by the General Assembly of 1929, under which the Station has accepted the task of examining the samples collected by the Commissioner of Agriculture.

Thus it will be seen that our duties are constantly increasing. The last addition to our building space was in 1912, when the main

laboratory was enlarged. To-day with a staff doubled in size we are very seriously crowded, with the result that it is increasingly difficult to carry on our work. New problems require new equipment and facilities which we are at present unable to house. At the last session of the General Assembly, an item of $45,000 for a new laboratory was included in our estimates, but this was eliminated from the budget. I present this as our greatest need and recommend that it be included in the estimates to be presented next fall.

CONTROL AND INSPECTION WORK

Inspection of Fertilizers, Feeds, Foods, Drugs, etc.

In accordance with the statutes relating thereto, the Analytical Chemistry Laboratory has analyzed 900 samples of *Fertilizers and Fertilizer Materials.* The report on these was published and distributed before the middle of December.

Similar control work on *Feeding Stuffs* has involved chemical analysis of more than 800 commercial and other fodder materials, many of which have had microscopic examination.

A report, Bulletin 307, upon food products and drugs summarizing inspection and analyses of 1320 samples, largely submitted by the Dairy and Food Commissioner, was issued in May of this year, covering the work done in the previous year. An equal volume of analytical work has been required in this branch of the service during the current year.

Statutes requiring the certification of *Glassware* used in the Babcock test for fat in milk and cream, and of thermometers to be used in dairies for checking pasteurization temperatures, have involved the examination of 2746 pieces.

No systematic inspection of *Insecticides* and *Fungicides* has been made but a considerable number of spray materials submitted by purchasers and others interested have been examined. A useful compilation of analyses (160 pages), of insecticides, fungicides, bactericides, rodenticides and weed killers was prepared and published in January of this year as Bulletin 300.

The department has also done a very considerable amount of analytical work in collaboration with the Tobacco Substation at Windsor and the Experiment Station at Storrs. Analyses of special foods have been made from time to time in coöperation with the American Medical Association's Council on Pharmacy and Chemistry. A review of the literature on color reactions for vitamins has been made and submitted to the Association of Official Agricultural Chemists and will be published in the journal of that

association. The laboratory has also continued to take part, with other control laboratories and industrial and trade laboratories in the United States, in programs of check analyses on cottonseed meal and on various fertilizer mixtures. And finally, the department is always interested in the examination of new food products and in special and miscellaneous food to the extent that time and facilities permit.

Control of Insect Pests

There has been no particular spread of the *Gipsy Moth* in Connecticut during the season. As in 1928, there was no noticeable defoliation of trees in Connecticut, but larger areas were stripped in Massachusetts, Maine and New Hampshire than ever before. We believe that this relative freedom from injury is due in large measure to the careful and thorough work in scouting and spraying carried on year after year in coöperation with the Federal forces.

The *Satin Moth* has continued to spread westward, and a State quarantine conforming with the Federal quarantine was placed on the eastern half of the State, effective March 15, 1929. The Federal quarantine was later revised, effective November 1, 1929.

The *European Corn Borer* has made an extensive spread, especially from the two-generation area in the eastern portion of the State. The entire State was scouted by Federal men and the pest found in 39 new towns. In revising quarantines, it has seemed best to include 30 of these infested towns together with seven towns not yet found infested but surrounded or nearly surrounded by infested towns, leaving nine towns in which clean-up work will be done.

The last General Assembly enacted a compulsory clean-up law, as a means of corn borer control, the compulsion depending upon orders and regulations issued by the Director of the Station for the quarantined area only. Federal agents patrolled the main highways along the margin of the quarantined area from July 15 to October 15.

There has been no important spread during the season of the *Japanese Beetle*. Federal agents scouted more than 60 of the cities and larger towns along the principal lines of traffic and shipping, and the only new infestation discovered was at Willimantic, where 21 beetles were found. Soil treatment was carried on at Hartford and New London in the infestation centers discovered in 1928, and where grubs were found. Notwithstanding this treatment, more beetles were caught in traps in both cities in 1929 than were found in 1928. Road patrol was maintained between June 15 and October 1 on the main highways leading out of the larger quarantined areas

The only infestation of the *Asiatic Beetle* discovered outside of the quarantined towns of New Haven and West Haven was in a small private yard in Bridgeport. On an inspection tour for lawn injury, approximately 52 towns were visited, mostly in the central and western portions of the State outside the Japanese beetle quarantined area, but no signs of infestation were found. The insect has been found in New Haven outside of the former infested area.

There has been an increase in the number of nurseries, all of which have been inspected since July 1 by the Station entomologists. We have also inspected the fruit and rose stocks imported from Europe for propagation in Connecticut nurseries.

In the *Mosquito Elimination* work very substantial progress has been made. New ditching in Old Lyme started in 1928 was continued in the spring of 1929, until the appropriation of $5,000 was exhausted. Another $5,000 was appropriated and work is now going on. Ditches are now being cut in Hamden and all of the salt marsh area in that town will soon be completed. Many ditches were recut in the East River section of Madison, and all ditches have been maintained except in certain portions of Madison and Guilford.

Distribution of Forest Planting Stock

During the calendar year 1929, the Station distributed 1,458,000 trees for forest planting, shelter belts and wind breaks; at least 99 per cent was for forest planting purposes. Of the entire amount, 463,000 trees were sent to farmers under the Clarke-McNary Act. The rest went to water companies, manufacturing plants, estate owners and others. This is an increase of 10 per cent more than the number distributed in 1928, showing an ever increasing interest in reforestation.

White Pine Blister Rust

During the season of 1929, 134,407 wild Ribes and 10,922 cultivated Ribes were destroyed on 34,597 acres, in 20 towns. Approximately 18 per cent of the acreage covered was re-eradication work.

Nursery Sanitation Zones have now been established around 11 nurseries, including one area established this year. The ten previously established zones were rechecked. Five thousand nine hundred and sixty acres were inspected on this project this year and 1,182 wild Ribes and 1,814 cultivated Ribes removed.

The European Black Currant law, effective July 1, 1929, gives the Director the authority to conduct a state-wide campaign on the

elimination of this plant, which is an alternate host of the Blister Rust. The presence of this species of Ribes constitutes the most serious menace to the white pine.

SUMMARY OF WHITE PINE BLISTER RUST CONTROL, 1928-1929

Year	Initial erad. ac.	Re-erad. acres	Total ac. erad.	Wild Ribes destroyed	Cult. Ribes destroyed
1925	6,688	40	6,728	258,515	684
1926	21,687	570	22,256	182,826	330
1927	12,068	8,836	20,904	159,121	2,235
1928	68,539	1,122	69,661	123,383	1,151
1929	28,394	6,203	34,597	134,407	10,922

Seed Testing

For more than 50 years seed testing for farmers has been one of the Station's activities, it having pioneered in this work. The General Assembly of 1929 passed a statute requiring that all seeds, except of vegetables and flowers, be labeled as to germination and purity. The Commissioner of Agriculture is charged with the administration of the act, and the Station is making the examinations. This will increase the duties of the Botany Department and some provision should be made for financing the work.

Spray Service

The spray service, so popular among fruit growers, is carried on in coöperation with the Extension Service of the Connecticut Agricultural College. The Station botanists and entomologists maintain constant touch with the development of fungous and insect pests and by use of special weather data furnished by the New Haven office of the Weather Bureau, are able to advise orchardists as to the time of the several spray applications. The warnings or "bulletins" are telephoned to the several County Agents, who in turn send them out over a previously arranged telephone chain.

PROGRESS OF INVESTIGATIONS

Here follow brief notes on those projects of special interest or on which definite results have been obtained during the year. No attempt is made to discuss all of the investigations under way, a list of which will be found on page 766.

Biochemistry

Cell Chemistry. The investigation of the tobacco leaf has been continued throughout the year. Existing methods for the determination of nitrate, ammonia and amide nitrogen have been so modified as to become applicable to tobacco which, owing to the presence of the volatile alkaloidal base nicotine, presents unusually difficult analytical problems. Pure specimens of nicotine have been prepared by a method especially developed for the purpose and the dissociation constants of this base have been determined. Curves drawn with the knowledge of these constants form the basis of a new method for the determination of "free nicotine" in tobacco, a matter of some importance in the judgment of tobacco quality. Three papers embodying the results of this work have been published.

Protein Chemistry. Two papers on the basic amino acids of crystallized horse hemoglobin and of the keratins of human hair respectively have been published in the *Journal of Biological Chemistry.* These investigations were undertaken as illustrations of the application of the recent modifications of the methods of base analysis to proteins with unusual distributions of amino acids. An investigation of methods for the preparation of the sulfur-containing amino acid cystine has been carried out as well as an investigation of the compounds that this substance forms with silver and copper. A method for the separation of cystine from histidine has been developed and employed in the analysis of the keratins of human hair.

Nutrition. An elaborate experimental investigation of the effect of certain inorganic constituents of the diet on the growth of bone tissue has been planned and in part completed. Various phases of this investigation are being conducted with the collaboration of scientists of other institutions, notably Yale University, the Johns Hopkins Medical School, and Vanderbilt University. This investigation is founded on a method of varying the proportions of the determining factors in the diet that was developed in this laboratory recently.

An investigation of the vitamin distribution in watercress has been completed. This widely used salad "green" has been shown to provide a rich source of vitamins A and E as well as a moderately rich source of B.

A study of the curious phenomenon known as "refection" in the rat has been completed. The existence of refection in a rat colony renders the investigation of vitamin B-bearing tissues difficult, if not impossible. The failure of our attempts to produce this phenomenon in our animals was therefore gratifying.

The biochemical laboratory has also coöperated with Dr. F. G. Benedict of the Nutrition Laboratory of the Carnegie Institution

of Washington at Boston in a study of the fundamental characteristics of the basal metabolism of the rat. The effect upon the basal metabolism of the rate at which the animal has been grown has also been investigated. It is now possible to grow animals at any prescribed rate within the growth capacity of the species and the detailed study of animals that have been grown at widely different rates is expected to lead to valuable conclusions regarding the optimal rate of growth.

The annual grants of the Carnegie Institution of Washington first made in 1904 to the late Dr. Thomas B. Osborne, and since 1912 jointly to Dr. Osborne and Prof. Lafayette B. Mendel, have broadened the scope of the Station's work in the field of biochemical investigation. This generous financial assistance has been continued through the current year by a grant to Professor Mendel and Dr. Vickery.

Botany

The Willow Scab Fungus. Work on this disease has continued. It was found in North America for the first time in 1927 by the Station Botanist, although it had been known for some years in Europe. Bulletin 302, March, 1929, presents the results of the investigation up to that time. During the past year further data have been obtained on the occurrence of this disease in the United States and Canada, on control by spraying and on the life history of the fungus itself.

Chestnut Blight. Some hope exists that the virulence of this fungus may decrease as time passes, and that we may in the future hope to reestablish this very valuable forest tree. Several lots of chestnut seedlings have been planted in various parts of the state to determine the amount of natural infection; also regular observations are being made at two locations on native trees under forest conditions to determine the spread of the fungus.

Damping-off of Vegetable Seedlings. This constitutes a source of considerable loss each year to the vegetable industry on both greenhouse and field crops. Various soil treatments are being compared in an effort to find one that is both effective and practical. Excellent results have been obtained by the use of acetic acid and formalin.

Entomology

Asiatic Beetle. The results of the investigations on the life history, habits and methods of control of the Asiatic beetle have been published as Bulletin 304. Work on the control of this insect by applying lead arsenate in varying amounts to the soil has been continued, as well as tests for the effect of such applications

on the germination and growth of the different kinds of grasses used in making lawns. New plots on several lawns in Westville were laid out to check work previously done with lead arsenate and to assure a correct method of application per unit area. Observations will continue for a few years.

Oriental Peach Moth. An investigation on the life history, habits and control of the Oriental peach moth has been under way for several years and the data have been assembled in Bulletin 313. No satisfactory control by means of applications has yet been discovered. Consequently, control or partial control by parasites has been given considerable attention. In the late summer a request was received from the Connecticut Pomological Society that the Station undertake to rear these parasites and distribute them in peach orchards in 1930. A study of possible methods was made and a constant temperature room and a work room were fitted up with the necessary cages and apparatus, and an electric refrigerator was installed. A portion of the greenhouse was assigned to this work and strawberry plants were grown in order to rear the strawberry leaf-roller, which is a host to one of the parasites, the *Macrocentrus ancylivora.*

Mexican Bean Beetle. During the summer, the Mexican bean beetle was found to be present in certain towns in Fairfield, Litchfield, Hartford and New Haven Counties, in the western half of the State. The first discovery was made by Dr. E. P. Felt, of Stamford. It is questionable whether this insect will become a serious pest in Connecticut, as it is thought to be near its northern limit. However, it has seemed best to conduct a brief study of the life history of this insect and methods of controlling it in Connecticut and therefore a new project is added to the list.

Cabbage Root Maggot. Investigations were carried on in the control of the cabbage root maggot, principally to determine whether or not the gains in yield were justifying the expense of the control methods. This project will be continued for another season.

Squash Vine Borer. Insecticides were used directly on the larvae of the squash vine borer to see whether the control of this pest could be made more effective.

Forestry

The Rainbow Forest. Originally planted to both conifers and hardwoods, this experimental forest is now essentially coniferous, the hardwoods having succumbed to disease, insects and unfavorable conditions. The soil is very sandy, too much so for cultivated crops or pasture and was selected as representing one type of our sub-marginal land. The plantings are in blocks of one or two

species and constitute not only a trial of the various species of coulfers, but of various spacings. As they have grown, experiments in thinning, pruning and other silvicultural practices have been possible. A complete discussion of the results up to 1924 is available in Bulletin 262.

Work during the year has included very little planting but considerable thinning. Several new sample plots have been laid out and the thinnings have been extended to other plantations which were in need of such treatment.

In coöperation with the Soils Department a study of pine leaf litter and its effect on sandy soil was begun. Several plots were laid out, from which the leaf litter was removed or treated in such a way as to alter its character, by burning or otherwise, so that a comparison might be made later with the check area where the litter was left in its natural condition. There is reason to believe that pine needles unmixed with hardwood leaves have a deleterious effect on soil couditions rather than otherwise. It is hoped that some definite data on this point will be secured through this experiment.

Treatment to Prolong the Life of Native Woods for Tobacco Shade Poles. The coöperative demonstration at the Tobacco Substation is being continued although no new posts have been set. It is planned to try out some other species in addition to those already under test.

The Distribution and Rate of Growth of the Forest as Influenced by Soil Conditions. The studies on the rate of growth of red pine in pure plantations have been continued and the result prepared for publication. Normal growth curves have been prepared, thus providing a "yardstick" by which growth on different sites can be computed to a common age and the quality of sites compared.

Plant Breeding

Hereditary Characters in Corn. The inheritance and linkage relations of a sterile tassel condition have been studied further and its possibilities for use in the production of crossed seed corn determined. This character is being introduced into the seed-parental stock of Canada-Leaming to be used in growing hybridized seed without detasseling. Other characters including sugary with abnormally high and low segregation, are being studied further.

Effects of Inbreeding and Crossing Upon Corn. The investigation bearing upon conflicting theories as to the interpretation of hybrid vigor is being continued but has not reached a stage where progress is to be reported.

Improvement of Naturally Cross-Fertilized Plants. Canada-Leaming, a cross of inbred strains of Canada Yellow Flint and

Leaming, has been tested the second year in Massachusetts, Vermont, New Hampshire and Maine and in spite of the unfavorably dry season has been outstanding in many places in its early maturity, large stalk growth and heavy production of grain. This companion of Burr-Leaming combines many of the qualities of earliness and hardiness of the flint type with the large stalk growth and grain yield of the dent type.

About 400 first generation crosses of inbred strains of Whipple's Early Yellow sweet corn were grown in a preliminary trial for a market garden type of sweet corn having the uniform size and shape of ear and even maturity characteristic of crossed corn. Some 30 of these have been selected for further trial.

A new hybrid type of canning Evergreen sweet corn has been tested three years. This has been named Green Cross and will be distributed to canners and seed growers in 1930.

A new variety of Early Yellow sweet corn called Spanish Gold has been developed by crossing an amber-colored flint corn from Spain with Alpha white sweet and Gaspe flint and other varieties of extreme earliness. The new variety in the trials at Mount Carmel has ripened earlier and produced somewhat larger ears than any other extra early variety grown in comparison with it. Seed will be distributed for general trial in 1930.

New varieties of straightnecked squash, early pepper, and spinach are ready for distribution for trial by market gardeners under various soil conditions and different methods of handling.

Preliminary results of inbreeding and crossing strawberries show that this plant behaves much the same as corn. With the added advantage of vegetative propagation it is to be hoped that valuable varieties can be originated in this way. Inbred strains of Harvard 17, Chesapeake and Glen Mary are being grown in the greenhouse for the purpose of making many crosses in a further test of this method.

Black raspberries show no reduction in growth or fruitfulness after two generations of self-fertilization. Strains differ in size, form and number of fruit as well as in cane and foliage color and other details of vegetation. Some strains are uniform and come true to type from seed. A comparison of seed propagation with tip-layering will be made to see if there is any advantage in the former method. Black raspberry plants are easily grown from seed and since these seedlings start free from mosaic there is a definite advantage in this method of propagation.

Improvement of Naturally Self-Fertilized Plants. The root-rot resistant strains of shade tobacco have continued to show a noticeable superiority in this respect over the variety generally grown. The origin and inheritance of this character are being studied. A combination of some of the growth characters of Round Tip tobacco with the quality and leaf characters of Cuban Shade is

being attempted. Several selections in this material are being tested for uniformity, growth habit and leaf quality.

A new variety of tomato combining the earliness of Alacrity with the shape and color of Bonny Best is being tested on various soils under market garden conditions.

Soils

Nutrient Requirements of Connecticut Soil Types. During the past four years 70 different soils representing practically all the important soil types of the State, under various conditions of former treatment, have been carefully studied as to plant food constituents and acidity as shown by chemical analysis, and as to the response of crops to various combinations of nitrogen, phosphorus and potassium, both with and without lime, under greenhouse conditions. The crops used include tobacco, alfalfa, lettuce, beets, carrots, cabbage, turnips, oats, buckwheat and sweet corn. These respond to lime in the following order from highest to lowest lime requirement of the crop: Lettuce, alfalfa, beets, carrots, cabbage, turnips, sweet corn, oats, tobacco and buckwheat.

Of the 70 soils, 67 need lime for lettuce, 64 for alfalfa, 60 for beets, 58 for carrots, 50 for cabbage, 43 for turnips, 40 for sweet corn, 34 for oats, 9 for tobacco and 4 for buckwbeat.

Nitrogen response under greenhouse conditions is so abnormally low, due to the favorable conditions for liberation of nitrogen from the soil, that no definite conclusions can be drawn. Of all the crops grown, oats appear to show the most marked response to nitrogen. Tobacco is the only other crop that bas shown definite symptoms of nitrogen deficiency on any appreciable number of soils.

Phosphorus is a serious limiting factor for nearly all crops grown in the case of 63 of the 70 soils. Three old tobacco soils included in the list failed to show response to phosphorus. Alfalfa, tobacco and turnips were almost complete failures on soils that are particularly low in this element. Data is somewhat irregular for other crops, but the approximate order of response to phosphorus was alfalfa, tobacco, turnips, sweet corn, cabbage, lettuce, carrots, oats, buckwheat.

Potassium is of such low availability that only six of the 70 soils fail to show measurable response. However, the majority of the soils produce somewhat higher yields without potash than without phosphorus. Differences in the potash requirement of the various crops are not sufficiently great to justify any statement as to order of response for the crops grown. Alfalfa and tobacco are the only ones that suffer markedly when the soil fails to supply sufficient potash.

Two other malnutritional abnormalities of tobacco have appeared

on some of these soils. On three very acid soils tobacco has shown symptoms of an excess assimilation of manganese (manganese toxicity). On several heavily limed soils where the fertilization has been deficient in nitrogen or potassium or both, a physiological trouble known as "frenching" has appeared. Factors affecting the occurrence of these troubles are being studied more fully.

Two year old maple transplants failed to show any consistent differences in growth on nine soils on which tobacco had previously shown marked response to the various nutrients. The experiment with young maple transplants will be continued for several years under outdoor conditions on a soil of marked nutrient deficiency.

In general, it may be stated that the soil type is less important than the past history of the field in determining the present nutrient requirements of the soil for the various crops. However, under field conditions, differences in the physical character of the soil, topography and stoniness will be of paramount importance in determining economic response to fertilizer and lime treatment.

Farm Soil Surveys. During 1928 and 1929 nearly two hundred farms in the towns of Woodstock, Griswold, Coventry, Brooklyn, Columbia, Stonington, North Stonington and Canterbury have been carefully surveyed as to soil types on the various fields of the farm. This is part of a project, the "Economic Significance of Soil Type," conducted in coöperation with the Agricultural Economics Department of the Storrs Agricultural Experiment Station. Soil acidity tests of practically every field on the above farms, a total of nearly 1500 tests, gives the following results:

0.5% of fields—neutral or above (7.0 + pH)
12.9% of fields—slightly acid (6.2-7.0 pH)
28.1% of fields—moderately acid (5.4-6.2 pH)
56.0% of fields—strongly acid (4.6-5.4 pH)
2.5% of fields—very strongly acid (3.8-4.6 pH)

Available phosphorus tests of all soils collected from three of the above towns show the following indications:

1.3% of fields—very high test (40 lbs. + per A)
4.7% of fields—high test (20 lbs.-40 lbs. per A)
6.6% of fields—medium test (10 lbs.-20 lbs. per A)
31.1% of fields—low test (5 lbs.-10 lbs. per A)
56.3% of fields—very low test (less than 5 lbs. per A)

A serious deficiency of available phosphorus undoubtedly exists on dairy farms in the highland regions of the State.

Leaching Experiments. During the spring of 1929 a battery of lysimeters was constructed at the Tobacco Substation in Windsor. This includes a long concrete-walled chamber built underground except for windows and roof, with raised earth platforms on each

side and at one end, in which the drainage cylinders are imbedded. The bottoms of these cylinders drain into brass, tin-lined tubes which lead through the walls and drain into collecting tanks on shelves along the walls of the chamber. The drainage cylinders, or lysimeters, are 20 inches in diameter. Thirty-four are 10 inches in depth while 34 are 20 inches in depth, the former filled with a seven-inch depth of surface soil, while the latter have also a ten-inch layer of subsoil. The capacity of the equipment provides for 34 additional lysimeters 30 incbes in depth which have not yet been installed. This equipment, built at a cost of $3,000, compares favorably with any other of its kind elsewhere and is the only apparatus in operation in New England that provides for collection and analysis of the soil and fertilizer constituents that are lost through leaching.

The first problem to be undertaken is a study of the losses occurring under heavy applications of various types of nitrogenous fertilizers. Sixteen different sources of nitrogen and four different types of soils are under investigation. The current season was exceptionally dry and practically no drainage water was collected until the entire crop was destroyed by hail on July 31. Much valuable data has since been collected which will be published later.

Forest Soil Studies. In coöperation with the Forestry Department of this Station, an intensive study of the soil factors affecting the site quality for red pine in plantations is being continued. Typical soils under various conditions of forest cover are being investigated in the laboratory as to biological, chemical and physical characteristics of the various soil horizons. Results to date indicate that the micro-organisms of the soil are most active in the fresh litter. In this layer organic nitrogen is being rapidly transformed into ammonia. Only a small part of this is transformed into nitrates in a three months' incubation period, except on soils of slight acidity. Ammonification occurs to a lesser degree in the older humus layer, which lies beneath the litter in forest soils where "mull" formation is not active. Nitrate formation rarely occurs in this type of material. The more favorable "mull" types, under hardwood cover, usually show nitrate production in the surface layer of mineral soil.

Three main groups of forest soils are represented in Connecticut. The first of these, the "podsol type," has a definite layer of light gray mineral soil occurring just beneath a thick humus covering. Below this gray layer are layers of dark coffee brown or rust brown color. This type is most general under hemlock-white pine-hardwoods associations in the northern part of the State, although it occurs locally in oak and beech forests in southern Connecticut. The second, or "mull type," has no older humus layer under the leaf litter, and the upper mineral soil is dark brown in color and of

a mellow, crumb-like structure. Earthworms are active. This type is characteristic of the best hardwood forests, where ash, elm, basswood, black and yellow birch and hard maple predominate.

A third or intermediate type has no definite gray layer beneath the forest humus, but there is an accumulation of leaf mold, and the upper mineral soil is firm and compact, with no earthworm activity to mix and mellow the soil. This is the most common type on the second growth and sprout hardwoods forests with a predominance of red and scarlet oak.

An important object in further research is to determine the factors that produce these forest soil types and to predict the effect of various silvicultural practices in modifying them.

Tobacco Substation

Despite the fact that the entire crop of tobacco on the station farm was ruined by hail August 1, satisfactory progress has been made on most of the active projects.

Shade Tobacco Resistant to Black Rootrot. The 4R strain that was found two years ago has proved this year to be very highly resistant to rootrot. This is particularly gratifying since the ordinary strain of Cuban shade tobacco is very susceptible to this disease and the losses have been very large. This should make it possible to grow shade on many fields that have been abandoned because of black rootrot.

Depressing Effect of Stable Manure. Tobacco was stunted and unusually poor on plots that received annual applications of stable or "adco" manure for four successive years. On these plots, the manure was used *in addition* to the regular commercial fertilizer application. The unusually dry season probably accounts for this behavior of the crop, which is quite different from the results of the wet seasons of 1927 and 1928.

Cause of Poor Combustion of a Dry Year Crop. Chemical comparison of tobacco of a dry season (1924) and a wet season (1927) shows the poor burning tobacco of the dry season contained more calcium, magnesium, phosphorus, sulfur, chlorine and nitrogen, all of which may be injurious to burn as measured on the leaf, while the good burning crop was distinguished by the increased potash, which aids comhustion. Also the alkalinity of the water soluble ash of the wet year crop was higher. This is considered a good index of combustability.

Seasonal Fluctuation in Soil Reaction. In trying to find the optimum soil reaction for tobacco production it will be necessary to take into consideration the period of the year when the test is made. On plots where monthly tests have been made for the past two years the reaction was found to be highest in December and lowest in June, the extreme variation being from .5 to 1.0 pH unit.

FIELD DAY

The Station field day at the Mount Carmel Farm, August 29, was one of the most successful we have ever had. Five hundred visitors gathered at the farm to inspect the experimental plots and to take part in the program. President George A. Works of the Agricultural College and Dr. E. W. Sinnott of Columbia University gave the principal addresses.

The Tobacco Substation Field Day was also well attended. Fifty of the visitors were members of a party of tobacco growers from Canada, who made this one of the important features of their tour.

The abandonment of the State Fair at Hartford relieved the staff of the very considerable task of preparing an exhibit. Several smaller exhibits were sent to town fairs.

LIBRARY

About 900 accessions of permanent value were added during the year to the Station library. Journals purchased now number 85, in addition to which some 30 farm journals and about 24 foreign agricultural journals are received regularly in exchange. The total number of bound volumes is now about 17,000.

PHYSICAL EQUIPMENT

The most extensive addition to the Station's equipment is the lysimeter installation at Windsor, mentioned elsewhere. Also the rat room of the biochemical laboratory has been completely renovated, new steel shelves and tables being installed. Other items are: a Pfaudler vacuum still, two electric refrigerators, a hydrogen sulfide apparatus, a Hobart chopping device for preparing forest litter samples, and a Parr combustion equipment for determining soil organic matter.

CHANGES IN STAFF

Appointments:

Henry Bull, M.F., Assistant Forester, August 1, 1929.
Miss Dorothy Amrine, B.Litt., Editor, July 1, 1929.
O. E. Street, M.S., Plant Physiologist, Tobacco Substation, July 1, 1929.
Mrs. Catherine R. Miller, M.A., Secretary Plant Breeding and Soils Departments, September 1, 1929.

Resignations:

Mrs. Mary B. Hunter, Secretary Plant Breeding and Soils Departments. August 31, 1929.

ACTIVE PROJECTS, 1929-1930

Analytical Chemistry

Dr. E. M. Bailey in charge

1. Inspection of Fertilizers.
2. Inspection of Feeding Stuffs.
3. Inspection of Foods and Drugs.
4. Calibration of Babcock Glassware and Thermometers.
5. Inspection of Insecticides and Fungicides.
7. Analysis of Special and Miscellaneous Foods.

Biochemistry

Dr. H. B. Vickery in charge
In Collaboration with Dr. L. B. Mendel, Yale University

1. Cell Chemistry.
   a. A detailed examination of the nitrogenous constituents of plant cells, in particular those of leaf tissues, and the further development of methods for the determination of the different forms of nitrogen in extracts of such tissues.
   b. An investigation of the nitrogenous constituents of the tobacco plant.
2. Protein Chemistry.
   a. The methods for the determination of the basic amino acids of proteins with the object of effecting improvements.
   b. Methods for the preparation of pure proteins on a large scale with the object of obtaining material for chemical and nutritional study.

Entomology

Dr. W. E. Britton in charge

3. Spraying and Dusting Experiments on Apples and Peaches. (With Botany.)
6. Control of Foul Brood of Bees. (Inactive.)
9. Insect Survey of Connecticut.
16. Experiments with the Cabbage Maggot.
17. Life History and Methods of Controlling the Oriental Peach Moth, *Laspeyresia molesta*.
18. Life History of Imported Currant Worm.
20. Life History, Habits and Control of the Imported Birch Leaf-Miner, *Fenusa pumila*.
21. Life History and Control of the Spinach Leaf-Miner.
26. Experiments on the Control of Squash Vine Borer.
27. (New) Rearing and Distributing Parasites of the Oriental Peach Moth.
28. (New) Investigations on Oil Sprays.
29. (New) Life History of the Mexican Bean Beetle.

Control Projects

10. Inspection of Orchards and Nurseries.
11. Control of Gipsy Moth. (With U. S. Dept. Agric.)
12. Elimination of the Mosquito Nuisance in Salt Marshes.
13. Inspection of Apiaries.
19. Control of the European Corn Borer. (With U. S. Dept. Agric.)
24. Control of the Asiatic Beetle. (With U. S. Dept. Agric.)
25. Control of the Japanese Beetle. (With U. S. Dept. Agric.)

Forestry

Mr. W. O. Filley in charge

1. Experimental Plantations on a Sandy Tract at Rainbow.
   a. Comparison of a wide variety of conifers and hardwoods.
   b. Methods of management for those species that have survived.
   c. Studies on growth and habits of the several species.
2. Effect of Thinning in White Pine. (At Shaker Station.)—Three Grades of Thinning.
3. Effect of Thinning in Hardwoods. (At Quassipaug Lake.)
5. Distribution of Forest Planting Stock. (Under Clark-McNary Act.)
6. Studies of Forest Plantations. (State-wide.)
   a. Comparative growth of various species.
   b. Reasons for success or failure.
   c. Soil and other site factors necessary for success of each species.
10. An Investigation of the Distribution and Growth of Forest Trees as Influenced by Soil Conditions and Other Site Factors.
11. Coniferous Seed Bed Study to Determine:
   a. The value of fertilizers in seed beds.
   b. The value of different amounts of seed.
   c. The value of dusts and sprays in preventing damping off.
12. A Study of Preservative Treatments of Native Woods.

Control Project

7. Control of White Pine Blister Rust. (With U. S. Dept. Agric.)

Genetics (Plant Breeding)

Dr. D. F. Jones in charge

1. A Genetic Study of Hereditary Characters in Corn Involving Their Linkage Relations and Variability, with particular attention to characters directly influencing yield.
2. The Effect of Inbreeding and Crossing upon Corn in Relation to Vigor, Rate of Growth, Productiveness and Variability.
3. Methods for the Improvement of Naturally Cross-Fertilized Plants by Selection in Self-Fertilized Lines, with particular attention to field corn for grain and ensilage, alfalfa, and to some of the more important Vegetable Crops, such as sweet corn for market gardening and canning, beets, cabbage, carrots, cucumbers, melons, onions, radish, rutabagas, squash and some Fruits such as bush fruits and strawberries.
4. Method for the Improvement of Naturally Self-Fertilized Plants, with particular attention to Tobacco and Vegetable Crops, such as lettuce, lima beans and tomatoes.

Soils

Mr. M. F. Morgan in charge

1. The general project "What Soil Characters are Factors in Determining the Agronomic Value of Utilization of Land" has developed into five distinct phases as follows:
   a. A descriptive inventory of Connecticut soil types, in relation to their adaptation for crops, pasture and forest.
   b. The physical and chemical characteristics of important soil types, including the nutritive response of tobacco and other plants when these soils are variously treated in the greenhouse.

c. Fertilizer experiments with vegetable crops on several typical soils in concrete frames.
d. A study of the physical, chemical and biological conditions of the soil in natural mixed and planted coniferous forests. (With Forestry Department.)
e. A study of the drainage losses and other changes that occur in several soils under heavy fertilization, as practiced for tobacco and vegetables. *(Lysimeter experiments at Windsor.)*

2. Experiments in Lawn Fertilization, Seeding and Management.

Tobacco Substation

Dr. P. J. Anderson in charge

1. Fertilizer Experiments: Various Sources and Rates of Nitrogen, Phosphoric Acid and Potash.
2. Field Tests with Farm Manure.
3. Field Tests with Manure Substitutes.
4. Tobacco Nutrition Studies: the Rôle of Nitrogen, Sulfur, Chlorine, *Potassium, Calcium, Manganese, Boron and Magnesium.*
5. Improvement of Havana Seed Tobacco.
6. Improvement of Broadleaf Tobacco.
7. *Improvement of Cuban Shade Tobacco.*
8. The Effect of Various Winter Cover Crops used on Tobacco Land.
9. Brown Root Rot of Tobacco. (With U. S. Dept. Agric.)
10. Studies on Black Root Rot of Tobacco.
11. Soil Reaction in Relation to Tobacco.
13. Preservative Treatment of Shade Tent Poles.
17. The Rôle of Humidity and Temperature in Curing Tobacco.

PUBLICATIONS

Bulletins

No. 296. Report on Commercial Fertilizers for 1928.
No. 297. The Effect of Topping and Suckering on Havana Seed Tobacco.
No. 298. Report of the Director for the Year Ending October 31, 1928.
No. 299. Report of the Tobacco Substation at Windsor for 1928.
No. 300. The Composition of some Commercial Insecticides, Fungicides, *Bactericides, Rodenticides and Weed Killers.*
No. 301. Control Studies on the Plum Curculio in Connecticut Apple Orchards.
No. 302. The Willow Scab Fungus.
No. 303. Report on Commercial Feeding Stuffs for 1928.
No. 304. The Asiatic Beetle in Connecticut.
No. 305. Report of State Entomologist for 1928.
No. 306. Soil Reaction and Liming as Factors in Tobacco Production in Connecticut.
No. 307. Report on Food Products and Drugs for 1928.

Bulletins of Immediate Information

No. 62. The Control of the Asiatic Beetle in Lawns.
No. 63. The European Corn Borer, a Menace to Corn, Vegetable and Garden Plants.
No. 64. The Japanese Beetle Quarantine.
No. 65. The Asiatic Beetle Quarantine.
No. 66. The Satin Moth Quarantine.
No. 67. Control of Ant Invasions. (Revised edition of Bulletin of Immediate Information No. 17, July, 1922.)

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WHAT THE STATION CAN DO

Each mail brings to the Station requests for information and service, the range of subjects being almost without limit. Every effort is made to comply with these requests, even though they are outside the fields under investigation. This is one of the purposes for which the library is maintained. However, some of the letters request help that requires an intimate knowledge of live stock management and the like and others ask us to make laboratory determinations for which we do not have the equipment or staff. Therefore it is helpful to publish from time to time a list of the subjects on which we can furnish information and the kinds of samples we can accept.

The Station can furnish information on:

Fertilizers and fertilization.
Soils and management.
The chemical composition of foods, drugs, insecticides and fungicides.
The composition of diabetic foods.
Insect pests of plants and their control.
Fungous and other diseases of plants and their control.
Sprays and spraying.
Fruits and fruit management.
Weeds and their control.
Forestry—all phases.
Care of shade trees.
Plant breeding—especially field and sweet corn.
Lawns, establishment and care.
Bees.
Mosquito elimination.
Tobacco culture.

Samples and specimens that can be analyzed, tested or identified:

Fertilizers.
Feeding stuffs.
Foods and drugs.
Milk—except for bacterial count.
Seeds.
Weeds and other plants.
Insects.
Diseased and injured plants.
Soils.

The Station cannot furnish information on:

Live stock feeding and management including poultry.
Animal diseases.
Household management.
Clothing.
Farm management.
Marketing and coöperation.

Requests for information on these subjects should be sent to the Connecticut Agricultural College at Storrs.

The Station cannot make analyses and examinations of:

Drinking water—apply to the State Board of Health, Hartford.

Milk for bacterial content—apply to the Dairy and Food Commissioner, Hartford.

Sick or dead poultry should be sent to the Poultry Department, Storrs Agricultural Experiment Station, Storrs, Conn.

All of which is respectfully submitted.

WILLIAM L. SLATE,
Director.

Bulletin 319 June 1930

THE THIRTY-FOURTH REPORT ON FOOD PRODUCTS

AND THE TWENTY-SECOND REPORT ON DRUG PRODUCTS

1929

Connecticut
Agricultural Experiment Station
New Haven

The bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to other applicants as far as the editions permit.

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THE TUTTLE, MOREHOUSE & TAYLOR COMPANY, NEW HAVEN, CONN.

THOMAS HOLT

The Station, and particularly this department, was grieved to learn of the sudden death on April 29, 1930, of Thomas Holt, Dairy and Food Commissioner. The operation of the food and drug law and of other regulations brought us into continual contact with him and his office, first as Deputy Commissioner and later as Commissioner, for a total period of 16 years. Good sense, sound judgment, hard work and kindly disposition characterized the man and his administration. There can be no better testimonial to his worth than that he grew constantly in the esteem and confidence of his fellow officials and others with whom he came in contact in his public service, and that in the more private relationships of his home and his home community he was held in respect and affection.

Material	Page	Sampled by, or Submitted to: The Station	Sampled by, or Submitted to: The Dairy and Food Commissioner	Total	Adulterated, below standard, or otherwise illegal
FOODS					
Beverages, soda water type	780	0	149	149	3
Malt, near beer type	780	0	23	23	2
Cereal products, etc.:					
Breakfast food, etc.	780	6	80	86	...
Flour, bread, etc.	787	5	0	5	...
Coffee	787	1	1	2	...
Eggs	788	2	2	4	...
Fats and oils:					
Butter	788	0	199	199	1
Oleomargarine	788	0	5	5	0
Olive oil	789	2	24	26	8
Foods, special and miscellaneous	789	54	0	54	...
Fruit products:					
Cider	794	0	5	5	...
Grape-fruit juice	794	0	2	2	...
Grape juice, etc.	794	3	1	4	...
Honey	794	3	0	3	...
Ice cream, etc.	794	5	301	306	4
Meat products:					
Hamburg steak	804	0	19	19	4
Frankfurts	805	15	9	24	8
Pork sausage	805	0	20	20	1
Meat loaf seasoning	805	0	1	1	0
Milk and milk products:					
Market milk	805	53	112	165	36[1]
Chocolate skimmed milk	806	0	4	4	0
Buttermilk, semi-solid	806	1	0	1	0
Evaporated milk	806	1	0	1	0
Powdered whole milk	806	1	0	1	0
Cream	806	2	0	2	0
Vinegar	808	11	340	351	64
Total for foods		165	1297	1462	131

[1] Not including samples below standard only.

Material	Page	Sampled by, or Submitted to: The Station	Sampled by, or Submitted to: The Dairy and Food Commissioner	Total	Adulterated, below standard, or otherwise illegal
DRUGS, ETC.					
Ammonia, aromatic spirits of	810	0	7	7	3
Calcium hydroxide, solution of	811	0	5	5	0
Camphor, spirit of	812	0	9	9	0
Ethyl nitrate, spirit of	813	0	13	13	7
Iodine, tincture of	814	0	10	10	1
Magnesium citrate, solution of	814	0	8	8	5
Peppermint, essence of	816	0	4	4	1
Rhubarb, comp.	816	0	1	1	...
Total for drugs		0	57	57	17
MISCELLANEOUS					
Drugs and other materials	817	19	2	21	2
Materials examined chiefly for poisons	818	50	5	55	...
Tobacco	818	170	0	170	...
Potatoes	820	22	0	22	...
Beets	820	17	0	17	...
Water (State Water Commission)	821	6	0	6	...
Total for miscellaneous		284	7	291	2
Total for all, exclusive of glassware		449	1361	1810	150
Babcock glassware and thermometers	821	2538	0	2538	21

FOOD PRODUCTS, THIRTY-FOURTH REPORT

DRUG PRODUCTS, TWENTY-SECOND REPORT

E. M. Bailey

The Department of Analytical Chemistry is primarily concerned with analytical and other work incidental to inspection and control of commercial fertilizers, feeding stuffs, foods, drugs and insecticides, and to the certification of glassware used in carrying out the Babcock test upon milk and cream, and of thermometers used in the control of the pasteurization of milk. The Statutes also provide for collaboration with the State Water Commission, if required, and as our facilities permit. A considerable amount of work is required each year due to an arrangement with the Storrs Agricultural Experiment Station, whereby analyses needed in connection with field experiments and feeding trials are made in this laboratory. Collaboration in tobacco investigations being carried on by this Station has involved the examination of more than 160 samples during the past year, requiring approximately 1,000 separate determinations. In addition to the preparation of annual reports upon inspection of fertilizers, feeding stuffs, and foods and drugs, the department has within the year assumed most of the office work connected with the annual registration of fertilizers and feeding stuffs.

This report summarizes work done for the year 1929 for purposes of food and drug inspection, samples for the most part being submitted by the Dairy and Food Commissioner. The report includes a large number of analyses of cereal breakfast foods and similar products taken from a previous bulletin[1] and supplemented by 86 new analyses, most of them representing new products. Various members of the staff have collaborated with referees of the Association of Official Agricultural Chemists in studies of methods of analysis for foods and drugs. The chemist in charge has continued to serve on two committees of that Association and in October, 1929, was elected its president. With this appointment the presidency of the Association comes to the Station for the fifth time. Service on the Food Standards Committee of the United States Department of Agriculture and as a consultant to the Council on Pharmacy and Chemistry of the American Medical Association has been continued.

The interested coöperation of the staff of this department in carrying on the work herein reported, and in all matters pertaining to the general conduct of the department's work, is gratefully acknowledged.

[1] Conn. Agric. Exp. Sta., Bull. 197. 1917.

FOODS

BEVERAGES

SODA WATER TYPE

The statutes relating to carbonated beverages of the soda water type are very generally observed. Only occasional samples are found to contain saccharin and the minimum limit for sugar, five per cent, is always exceeded. Artificial colors and flavors are indicated by suitable declarations.

One hundred and forty-nine samples were submitted by the Dairy and Food Commissioner. One, sample 41947, lemon and lime soda, purchased of J. Richmond and Son, Moosup, contained saccharin. Sample 42487, Pale Moon, purchased of C. Manwaring and Son, Niantic, contained artificial color, which was not declared. Sample 41932, strawberry soda, purchased of the Newgate Ginger Ale Company, Thompsonville, bore misleading statements of equivalent food value.

NEAR-BEER

Twenty-three samples of malt beverages of the "near-beer" type were submitted by the Dairy and Food Commissioner. Two of these were found to contain caffeine in amounts ranging from 0.8 to 0.9 of a grain per bottle of 12 fluid ounces. Objection was taken to these products for the reason that caffeine is an added substance foreign to the article generally known as beer, which these beverages purport to be. The products bore labels of the Munch Brewery and the Edelbrau Brewing Co., both of Brooklyn, New York.

CEREAL PRODUCTS, ETC.

CEREAL BREAKFAST FOODS, ETC.

Analyses of breakfast foods and of similar preparations have been given in previous bulletins[1] of this Station. During the past year a considerable number of analyses has been added, which represent many products not included in previous summaries. Table I includes the older analyses together with those of products examined recently. Eighty-six new analyses have been added to the list. All of the samples were submitted by the Dairy and Food Commissioner, with three exceptions.

The classification of products is suggested largely by the name of the article or by information at hand concerning its origin. In the case of mixtures or of products the names of which do not suggest the proper grouping, some errors of classification may occur. Besides the ordinary breakfast foods the list includes so-called "health" and laxative preparations.

[1] Conn. Agric. Exp. Sta., Bull. 197, 1917; Ibid., Bull. 286. 1927.

TABLE I. ANALYSES OF CEREAL BREAKFAST FOODS, ETC.

Description of Food	Water	Ash	Protein	Fiber	Carbohydrate (other than fiber)	Fat	Calories per 100 gms.
	%	%	%	%	%	%	
Barley preparations:							
Cream of Barley	9.2	1.4	11.1	0.6	76.1	1.6	363
*Cris Cross Brand Barley Crystals Breakfast Cereal	9.2	1.1	9.7	0.8	78.3	0.9	360
Farwell & Rhines' Barley Crystals	9.9	1.2	11.5	0.9	75.2	1.3	359
*Lust's Old Fashioned Barley Health Food	5.3	2.4	12.2	11.9	66.2	2.0	332
Quaker Scotch Brand Pearled Barley	12.1	1.0	9.5	0.3	76.2	0.9	351
Corn (maize) preparations:							
Cerealine	11.2	1.5	6.9	0.1	79.9	0.4	351
E-C Corn Flakes Toasted	12.1	2.2	6.6	0.2	78.6	0.3	344
F. S. Granulated Hominy	13.3	0.4	8.0	0.2	77.1	1.0	349
Hecker's Cream Hominy	11.7	0.3	9.8	0.5	77.3	0.4	352
H. O. New Process Hominy	11.3	0.4	8.0	0.2	79.8	0.3	354
Jackson's Roman Meal	8.5	3.7	13.3	5.0	66.1	3 4	348
Jersey Corn Flakes	7.7	0.9	8.5	0.3	82.3	0.3	366
*Kellogg's Corn Flakes	4.4	2.5	7.2	0.6	85.1	0.2	371
Kellogg's Toasted Corn Flakes	11.7	2.7	6.4	0.2	78.8	0.2	343
Korn Kinks	12.0	2.2	7.4	0.1	77.9	0.4	345
Nichols' Snow White Samp	13.4	0.3	7.8	0.5	77.7	0.3	345
*Pillsbury's Hominy Grits	8.5	0.3	7.8	0.6	82.2	0.6	365
*Post's Corn Flakes	7.6	2.3	7.1	0.5	82.1	0.4	360
Post Toasties	11.7	1.8	6.6	0.2	79.4	0.3	347
Quaker Best Yellow Corn Meal	12.3	0.5	7.5	0.2	78.7	0.8	352
Quaker Corn Puffs	12.0	0.4	8.7	0.1	78.5	0.3	352
Quaker Toasted Corn Flakes	11.6	1.3	6.8	0.0	79.9	0.4	350
Ralston Hominy Grits	11.3	1.0	9.0	0.4	75.4	2.9	364
*Royal Scarlet Toasted Corn Flakes	7.6	2.1	7.5	0.7	81.6	0.5	361
Street's Perfection Hominy	12.4	0.4	7.9	0.1	77.9	1.3	355
Sunbeam Pearl Hominy	14.3	0.4	9.4	0.3	75.0	0.6	343
*Sunbeam Toasted Corn Flakes	7.4	2.2	7.5	0.7	81.6	0.6	362
*Sunny Corn	8.5	0.4	8.4	0.6	81.5	0.6	365
Sunseal Sunny Corn	12.3	0.4	8.3	0.4	78.2	0.4	350
Sunseal Cream Corn Meal	12.0	0.5	8.9	0.4	77.2	1.0	353
Sunseal Hominy Grits	11.6	0.5	8.5	0.4	77.8	1.2	356
*Three Minute Hominy Grits	8.6	0.3	8.4	0.5	81.8	0.4	365
Washington Corn Crisps	12.1	2.9	7.8	0.2	76.8	0.2	340
Quaker Hominy Grits	13.2	0.5	7.9	0.2	77.7	0 5	347

* Analyzed in 1929.

TABLE I. ANALYSES OF CEREAL BREAKFAST FOODS, ETC.—*Continued*

Description of Food	Water	Ash	Protein	Fiber	Carbohydrate (other than fiber)	Fat	Calories per 100 gms.
	%	%	%	%	%	%	
Oat preparations:							
Bestovotes	11.0	2.1	16.2	1.0	63.1	6.6	377
Bufceco Rolled Oats	11.1	2.0	15.1	1.0	64.0	6.8	378
Fruited Oats	9.7	3.3	13.1	1.3	68.2	4.9	369
Grandmother's Crushed Oats	10.7	1.9	14.9	0.6	65.4	6.5	380
Health Brand White Oats	10.9	2.0	13.8	1.0	64.5	7.8	383
Hecker's Cream Oat Meal	11.5	1.8	15.6	0.9	64.6	5.6	371
*H-O	7.2	2.0	14.8	1.4	67.8	6.8	392
Hornby's Steam Cooked Oat Meal	10.6	1.7	16.1	0.8	64.1	6.7	381
Keen & Robinson's Granulated Scotch Oatmeal	10.4	1.9	13.7	0.8	64.1	9.1	393
*Lee's Quick Cooking Rolled Oats	7.6	2.1	14.1	1.5	67.6	7.1	391
Leggett's Premier 15 Minute Oat Flakes	11.3	1.8	17.2	0.6	63.7	5.4	372
*Mascot Brand Rolled Oats	7.0	1.8	13.6	1.5	68.9	7.2	395
McCann's Irish Oat Meal	9.2	1.8	15.1	0.3	64.9	8.7	398
Mother's Crushed Oats	10.9	1.6	15.6	0.9	64.9	6.1	377
*Mother's Quick Cooking Oats	7.4	1.9	14.2	1.3	67.9	7.3	395
*New Oata	7.7	1.9	15.8	2.1	67.8	4.7	376
Paw-Nee Rolled Oats	10.8	1.9	15.8	0.8	64.0	6.7	380
Purity Rolled Oats	13.5	2.0	16.3	1.0	61.1	6.1	365
Quaker Oats	10.8	1.9	15.9	0.9	64.5	6.0	376
*Quaker Oats	7.5	1.8	15.8	1.3	67.3	6.3	389
Robinson's Patent Groats	8.4	1.8	12.8	0.7	67.7	8.6	399
*Scotch Brand Oats	7.1	1.9	14.4	1.3	68.5	6.8	392
*Scotch Oat Meal	5.2	1.9	12.6	1.3	70.6	8.4	409
Scotch Porage Oats	10.1	1.7	13.3	0.4	64.9	9.6	399
Sovereign 15 Minute Oat Flakes	10.8	2.0	16.5	0.9	64.0	5.8	374
*Three Minute Oat Flakes	7.6	1.7	15.9	1.1	67.6	6.1	390
White Rose Rolled Oats	10.3	1.9	14.3	0.7	64.8	8.0	388
Rice preparations:							
*Comet Brown Rice Flakes	6.8	3.9	7.5	1.0	79.4	1.4	361
Comet Cereal	11.3	0.3	7.2	0.2	80.7	0.3	354
Cook's Flaked Rice	12.6	0.4	7.8	0.2	78.9	0.1	348
Cook's Malto Rice	11.3	0.6	7.6	0.1	80.2	0.2	353
*Cream of Rice	9.3	0.7	7.6	0.6	81.3	0.5	361
*Heinz Rice Flakes	4.2	3.1	7.6	4.2	80.4	0.5	357
*Kellogg's Rice Krispies	5.0	2.4	6.9	0.5	84.8	0.4	371
Kellogg's Toasted Rice Biscuit	5.0	3.7	10.1	0.2	80.7	0.3	366
Kellogg's Toasted Rice Flakes	4.7	3.4	10.0	0.2	81.3	0.4	369
Milk Rice	12.3	3.2	6.9	0.2	77.2	0.2	338
Quaker Puffed Rice	12.2	0.4	7.6	0.1	79.5	0.2	350

* Analyzed in 1929.

TABLE I. ANALYSES OF CEREAL BREAKFAST FOODS, ETC.—*Continued*

Description of Food	Water	Ash	Protein	Fiber	Carbohydrate (other than fiber)	Fat	Calories per 100 gms.
	%	%	%	%	%	%	
Rice preparations—Concluded:							
*Quaker Puffed Rice	6.5	0.4	6.4	0.5	86.0	0.2	371
*Toasted Rice Flakes	7.3	3.4	7.3	0.5	81.2	0.3	357
*White House Rice Flakes	8.9	4.8	7.4	1.4	75.2	2.3	352
Rye preparations:							
Cream of Rye	11.5	1.7	12.0	1.4	71.8	1.6	350
*Cream of Rye	8.3	1.7	9.9	1.3	77.8	1.0	359
Kellogg's Toasted Rice Flakes	8.1	2.2	11.4	0.6	76.2	1.5	364
Ry-Krisp	5.8	2.8	14.0	1.3	74.4	1.7	369
*Ry-Krisp	6.5	3.6	13.0	2.1	73.3	1.5	359
Wheat preparations:							
Alber's Wheat Flakes Mush	11.5	1.6	11.1	0.3	73.4	2.1	357
Cero-Vita	4.6	3.5	8.9	0.3	82.0	0.7	370
Cinnamon Rusks	9.9	0.7	10.3	0.2	71.7	7.2	393
*Cream Farina	9.3	0.5	11.4	0.6	77.5	0.7	362
*Cream of Wheat	8.5	0.6	12.3	0.6	77.2	0.8	366
Cream of Wheat	13.1	0.6	11.5	0.2	73.7	0.9	349
Cresco Grits	11.1	0.6	17.8	0.5	68.6	1.4	358
*Cris Cross Brand Whole Wheat Breakfast Cereal	9.6	1.7	12.3	2.2	72.4	1.8	355
Crystal Wheat	9.5	1.9	11.3	1.7	73.6	2.0	358
Dieto Rusks	6.4	1.5	15.9	1.0	66.1	9.1	410
*"Force" Toasted Wheat Flakes	6.4	3.0	10.3	1.3	77.2	1.8	366
Force	10.7	2.8	10.6	1.1	73.7	1.1	347
F. S. Farina (Quaker Farina)	13.7	0.4	10.2	0.2	74.6	0.9	347
Fruited Wheat	9.9	3.6	15.6	2.4	66.2	2.3	348
Grandmother's A. & P. Farina	12.9	0.6	10.8	0.1	75.0	0.6	349
Granola	6.1	2.3	13.9	0.6	76.3	0.8	368
Granose Biscuit	11.3	3.9	10.3	1.8	71.1	1.6	340
Granose Flakes	6.0	3.9	10.3	0.5	75.4	3.9	378
Hecker's Farina	12.7	0.6	10.0	0.1	75.9	0.7	350
Holland Rusk	11.0	1.3	12.1	0.1	70.4	5.1	376
Jireh Frumenty	6.2	1.4	12.3	1.1	77.3	1.7	374
Jireh Whole Wheat Farina	6.2	1.8	12.9	2.2	74.6	2.3	371
Kellogg's Breakfast Toast	7.7	1.6	13.6	0.3	74.9	1.9	371
Kellogg's Krumbles	10.0	2.6	12.0	1.9	72.3	1.2	348
*Kellogg's Krumbles	6.3	3.3	11.5	1.9	75.3	1.7	362
*Kellogg's Shredded Whole Wheat Biscuit	7.7	2.2	12.3	2.2	73.8	1.8	361
Kellogg's Toasted Wheat Biscuit	5.8	2.4	14.2	1.5	74.7	1.4	368

* Analyzed in 1929.

TABLE I. ANALYSES OF CEREAL BREAKFAST FOODS, ETC.—*Continued*

Description of Food	Water	Ash	Protein	Fiber	Carbohydrate (other than fiber)	Fat	Calories per 100 gms.
	%	%	%	%	%	%	
Wheat preparations—Concluded:							
Kellogg's Toasted Wheat Flakes	5.2	2.7	9.3	1.2	80.5	1.1	369
Kellogg's Zwieback	6.2	1.6	14.3	0.2	76.1	1.6	376
Leggett's Premier Farina	14.1	0.5	11.1	0.1	73.3	0.9	346
*Mack's Wheat Toast	5.9	2.4	12.9	1.3	66.9	10.6	415
*Malt Breakfast Food	6.2	1.8	13.6	1.5	75.4	1.5	370
Malt Breakfast Food	9.6	1.4	13.8	1.0	72.7	1.5	360
Manana Gluten Breakfast Food	7.6	2.5	42.6	1.7	43.6	2.0	363
*Mapl-Flake	6.9	3.8	8.5	2.0	77.3	1.5	357
Mapl-Flake	10.8	2.8	9.3	1.2	74.7	1.2	347
*Mello Wheat	9.7	0.4	11.3	0.6	77.3	0.7	361
*Monarch Food of Wheat	9.3	0.5	11.3	0.5	77.4	1.0	364
*Monarch Leenie Weenie Wheat Hearts	8.2	0.4	11.9	0.5	78.5	0.5	367
Mother's Wheat Hearts	13.5	0.4	10.7	0.2	74.1	1.1	349
Pettijohn's Breakfast Food	10.3	1.7	9.1	2.0	74.9	2.0	354
*Pettijohn's Rolled Wheat	7.7	1.5	14.4	2.5	71.9	2.0	364
Pillsbury's Best Cereal	11.3	0.5	11.5	0.1	75.9	0.7	356
*Pillsbury's Farina	8.0	0.5	12.1	0.5	78.1	0.8	368
*Pillsbury's Vitas Wheat	8.4	0.5	10.9	0.4	79.0	0.8	367
Quaker Cracked Wheat	11.7	1.7	9.3	1.7	73.3	2.3	351
*Quaker Farina	8.9	0.3	11.4	0.5	78.1	0.8	365
*Quaker Puffed Wheat	6.3	1.6	14.3	2.1	74.2	1.5	368
Quaker Puffed Wheat	11.5	1.8	13.1	1.6	70.2	1.8	349
Quaker Wheat Berries	9.8	1.4	14.0	1.2	71.6	2.0	360
Ralston Health Food	12.4	1.4	11.9	1.1	71.5	1.7	349
*Ralston Wheat Flakes	5.8	4.0	9.6	1.7	77.4	1.5	362
Ralston Wheat Food	11.9	1.1	11.3	0.8	73.1	1.8	354
Sanitas Granuto	4.9	1.3	10.1	0.4	81.6	1.7	382
Saxon Wheat Food	9.8	0.8	12.8	0.5	74.4	1.7	364
Shredded Wheat Biscuit	8.5	1.5	11.0	2.6	75.0	1.4	357
*Shredded Whole Wheat	6.5	1.6	12.9	2.4	74.6	2.0	368
Street's Perfection Farina	13.1	0.5	10.3	0.1	74.9	1.1	351
Triscuit	10.3	1.7	11.0	1.7	73.9	1.4	352
Vitos	11.6	0.5	11.1	0.2	75.6	1.0	356
*Vita-O-Wheat	7.8	1.3	12.6	1.1	75.0	2.2	370
*Wheatena	6.8	1.6	11.9	1.6	75.6	2.5	372
Wheatena	10.4	0.7	11.3	0.6	74.2	2.8	367
Wheatlet	12.2	0.8	12.8	0.3	72.3	1.6	355
*Wheatsworth Whole Wheat	8.4	6.6	11.4	1.9	70.2	1.5	340
Whole Grain Wheat (prepared)	66.2	1.5	6.6	1.2	23.7	0.8	128
*Whole Wheat Flake Wheaties	7.4	4.6	13.5	1.7	71.3	1.5	353
Zest	10.7	2.6	9.0	1.2	75.3	1.2	348

* Analyzed in 1929.

TABLE I. ANALYSES OF CEREAL BREAKFAST FOODS, ETC.—*Continued*

Description of Food	Water	Ash	Protein	Fiber	Carbohydrate (other than fiber)	Fat	Calories per 100 gms.
	%	%	%	%	%	%	
Wheat bran:							
Ballard's Obelisk Sanitary Edible Bran	11.5	4.5	17.3	5.6	55.7	5.4	301
Culp's Capitol Health Bran	11.2	5.3	13.4	8.2	57.6	4.3	323
*Dina-Mite Wheat Bran Flax	8.7	2.8	14.4	4.0	66.1	4.0	358
Health Food Co.'s Wheat Bran	11.6	5.6	14.3	8.2	56.2	4.1	319
Jireh Wheat Bran	11.1	4.3	16.8	6.3	56.7	4.8	337
*Johnson's Educator Bran	7.8	5.9	15.6	8.8	57.0	4.9	335
Johnson's Educator Wheat Bran	11.6	6.1	15.4	7.8	54.4	4.7	322
*Kellogg's Bran Flakes	6.7	3.6	10.9	2.8	74.2	1.8	357
Kellogg's Sterilized Wheat Bran	9.6	6.0	16.3	8.5	54.4	5.2	330
*Monarch Wheat Bran	7.3	6.3	14.0	10.8	56.7	4.9	327
*Pillsbury Wheat Bran	6.0	6.9	16.0	9.3	57.6	4.2	332
Wheat Bran Biscuit and other laxative preparations:							
Bran Bisque	8.5	3.1	12.1	2.2	61.0	13.1	410
Bran-eata Biscuit	9.8	4.4	9.1	3.6	72.2	0.9	333
Bran Zos	11.9	3.0	13.2	3.8	65.6	2.5	338
*Brose	7.3	3.1	14.2	4.1	67.1	4.2	363
Brose Good Health Breakfast Food	10.1	2.6	14.4	3.1	65.5	4.3	358
*Cellu Bran	3.9	4.6	3.6	20.8	37.1	30.0†	433
Cerag	9.2	3.6	11.3	2.0	73.0	0.9	345
Cerena	7.2	4.9	27.8	2.4	46.3	11.4	399
Christian's Laxative Bread	9.9	2.8	10.0	1.3	74.6	1.4	354
Christian's Laxative Cereal Flakes	13.0	1.7	10.4	1.0	72.5	1.4	344
Colax	13.1	2.1	1.1	0.1	82.8	0.8	343
Dietetic Bran Biscuit	9.3	5.0	9.9	1.7	69.1	5.0	361
Educator Bran Cookies	7.1	3.3	8.9	1.5	64.7	14.5	425
Educator Bran Meal	11.8	2.9	12.3	3.8	66.4	2.8	340
F. B. A. Laxative Health Biscuit	11.1	3.1	6.1	0.7	77.3	1.7	349
*Fig and Bran	6.3	7.1	13.3	7.8	62.6	2.9	330
Fruit Nut Cereal	7.3	3.2	13.5	2.4	72.4	1.2	354
Good Health Biscuit (Kellogg)	10.9	4.2	7.7	1.5	74.5	1.2	340
Health Food Wafers	9.7	5.3	10.0	1.4	65.7	7.9	374
India (Digestive) Biscuit	8.7	5.0	12.8	5.2	66.1	2.2	335
*Kellogg's All Bran	6.0	7.4	14.4	6.3	63.5	2.4	333
Laxa	6.6	5.0	12.4	6.6	66.6	2.8	341

* Analyzed in 1929.
† Largely mineral oil.

TABLE I. ANALYSES OF CEREAL BREAKFAST FOODS, ETC.—*Concluded*

Description of Food	Water	Ash	Protein	Fiber	Carbohydrate (other than fiber)	Fat	Calories per 100 gms.
	%	%	%	%	%	%	
Wheat Bran Biscuit and other laxative preparations—Con.							
Laxative Biscuit (Kellogg)..	9.4	3.0	16.7	2.4	57.7	10.8	395
*Lust's Original Fig Bran ..	5.9	5.7	11.3	5.9	69.4	1.8	339
Mansfield's Agar Agar Wafers	7.9	2.3	7.1	0.8	69.9	12.0	416
Oval Digestive Biscuit (H. & P.)	8.8	2.1	7.8	0.5	64.5	16.3	436
*Post Bran Flakes	6.3	4.7	14.4	3.5	68.9	2.2	353
*Prepared Bran	5.4	6.1	18.3	14.2	51.9	4.1	319
*Raisin Bran	6.0	2.4	13.7	1.9	74.0	2.0	369
*Sanitarium Cooked Bran ..	4.8	6.8	16.9	9.5	57.7	4.3	338
*Sanitarium Fig and Bran Flakes	4.8	5.9	11.5	4.4	71.0	2.4	352
Uncle Sam Health Food	6.3	3.1	21.3	4.0	40.9	24.4	468
*Uncle Sam's Laxative Food	6.2	3.3	18.8	3.5	52.9	15.3	425
Zim	13.2	2.0	7.4	1.5	74.2	1.7	342
Miscellaneous preparations:							
*Alvita Breakfast Cereal ...	8.7	1.8	15.1	2.3	68.8	3.3	365
*Branola	7.7	2.7	13.5	3.8	69.8	2.5	356
Dieto Nut Cereal	5.0	2.0	21.6	1.2	51.8	18.4	459
Dieto Wheat and Barley Cereal	6.8	1.7	11.6	2.0	75.7	2.2	369
*Enright's Old Fashioned Cereal	8.7	1.5	15.4	2.3	69.9	2.2	361
Grape Nuts.	10.3	1.9	11.5	1.5	74.2	0.6	348
*Grape Nuts	3.7	2.5	11.6	1.5	78.5	2.2	380
*Hoyt's Gluten Bran Flakes	6.2	2.9	52.9	4.1	28.2	5.7	377
Jireh Wheat Nuts	7.6	2.3	19.0	1.0	54.5	15.6	434
*Kellogg's Pep	5.3	3.2	10.2	2.4	77.1	1.8	366
*Lima Bean Flakes	5.9	2.5	13.8	2.4	74.2	1.2	363
Malabar Manoca	13.3	1.3	0.6	0.6	84.1	0.1	340
*Melba Vegetized Toast	9.4	2.4	13.4	1.5	62.7	10.6	400
*Melba Vegetized Toast	6.6	2.2	14.3	1.7	65.9	9.3	405
*Muffets	6.7	1.7	12.1	2.3	76.0	1.2	363
Post Tavern Porridge	12.7	1.5	10.3	0.2	74.5	0.8	346
Post Tavern Special	9.9	0.9	10.9	0.3	76.9	1.1	361
*Post Toasties	6.6	2.9	7.2	0.6	82.3	0.4	361
*Ralston's	8.3	1.2	13.7	1.4	74.0	1.4	363
*Roman Meal	7.7	4.8	15.3	5.4	63.6	3.2	345
*Roman Meal	7.7	2.8	12.2	3.8	70.8	2.7	357
Sea Moss Farina	15.6	13.6	9.1	1.5	59.9	0.3	279
Sunbeam Tapioca	13.5	0.2	0.6	0.1	85.5	0.1	345
*Sunera	10.2	1.5	12.0	1.7	74.0	0.6	349
*Toasted Bran-Gluten Flakes	6.2	3.6	51.9	6.7	24.9	6.7	368
*Trix	6.7	2.3	14.6	0.7	72.8	2.9	376
Trix	6.2	1.5	14.5	0.3	77.3	0.2	369
Trufood (Trufood Co.)	5.7	1.4	11.5	1.8	77.1	2.5	377
*Vita-Bits	5.4	3.9	13.8	3.1	71.9	1.9	360
Zep (Battle Creek Food Co.)	5.0	2.9	14.0	1.3	74.6	2.2	374
*Zo	5.0	3.3	13.4	1.8	74.9	1.6	368

* Analyzed in 1929.

WHOLE WHEAT FLOUR

Through the courtesy of a local flour mill the laboratory had an opportunity to examine a sample of whole wheat flour and one of Graham flour as made at that mill, and also a sample of the wheat grain from which these products were made. It was pointed out to us that the only difference between the two flours was in degree of fineness, the Graham product being coarser than the whole wheat product. Within the limits of reasonable analytical error these three samples show the same composition, as we would expect them to do.

The analyses are as follows:

	No. 2950 Whole wheat flour %	No. 2951 "Graham flour" %	No. 2952 Wheat grain %
Moisture	10.63	10.53	10.23
Ash	1.64	1.75	1.67
Protein (N x 5.7)	13.22	13.45	13.17
Fiber	2.43	2.63	2.40
Carbohydrate, other than fiber, by difference	69.73	69.09	70.18
Fat (ether extract)	2.35	2.55	2.35
Protein-ash ratio	8.00	7.70	7.90

BREADS, WHOLE WHEAT AND OATMEAL

Two samples of bread, one featured as a whole wheat loaf and the other as an oatmeal loaf, were analyzed. The whole wheat loaf was made from whole wheat and first clear flours and the oatmeal loaf was made from stone ground oatmeal, whole wheat flour and rye flour.

In the absence of official definitions for products of these types there is no objection to the names "whole wheat" and "oatmeal" as applied to these respective products.

The analyses are as follows:

	No. 2916 Whole wheat bread %	No. 2917 Oatmeal bread %
Moisture	35.54	32.52
Ash	2.06	2.08
Protein (N x 6.25)	10.08	10.74
Fiber	1.10	0.62
Carbohydrate, other than fiber, by difference	46.22	48.92
Fat	5.00	5.12

COFFEE, ETC.

A sample of Dacosta liquid coffee, 40926, submitted by the Dairy and Food Commissioner, was analyzed as follows:

Total solids	8.78%
Nitrogen, total	0.29
Ash	1.54
Water-insol. ash	0.22
Acid-insol. ash	0.009
Alkalinity of water-soluble ash	18.38[1]
Alkalinity of water-insol. ash	4.88[1]
Caffeine	0.42

[1] N/1 HCl, cc. per 100 gms. sample.

A sample of Al-Mo-Co, a mixture of cereal, coffee, molasses and chicory according to declaration, was examined. It contained 0.18 per cent of caffeine.

This product is claimed to be 99.74 per cent caffeineless. Probably this means that it contains 0.26 per cent of caffeine and that the remainder, 99.74 per cent, is non-caffeine material. Construed in this way our result substantiates the claim. However, it may not be clear to everyone that ordinary coffee is 98.8 per cent non-caffeine material, assuming 1.2 per cent as a fair average for the caffeine content of coffee. Al-Mo-Co contains about one-seventh as much caffeine as does ordinary coffee.

EGGS

Two samples of eggs were examined for the Dairy and Food Commissioner and both passed as fresh eggs.

Two unofficial samples were examined, one of which was not fresh and the other was classed as inedible.

FATS AND OILS

BUTTER

One hundred and ninety-nine samples of butter from retail stores were submitted by the Dairy and Food Commissioner during the year.

Standard butter should contain not less than 80 per cent of fat and not more than 15.99 per cent of water. Only one sample was found to be substantially outside these limits. All of the others fully satisfied the legal requirements or varied so slightly from them that they were passed without question. The deficient sample, purchased of Ferrera and Co., New Canaan, contained 20.7 per cent of moisture and 77.3 per cent fat.

OLEOMARGARINE

Five samples of oleomargarine were submitted by the Dairy and Food Commissioner to be examined for color. These were tinted products, which fact led to the suspicion that they were in violation of our statute. No objection is raised to the sale of oleomargarine somewhat colored by reason of the natural color of ingredient fats or oils which may impart some degree of yellow color to the finished product. The law prohibits the sale of oleomargarine to which artificial color has been added for the sole purpose of producing color. An act of Congress permits artificial color to be added to butter without declaration or other restriction.

Examination of these products disclosed no artificial color present. This was later substantiated by information as to the

process of manufacture, and further confirmed in two instances by information that the government imposed a tax of only one-quarter of a cent per pound, which is the rate provided for uncolored oleomargarine.

OLIVE OIL, ETC.

Twenty-three samples of olive oil and one of salad oil were examined, 16 of which were not found adulterated. Eight were adulterated, misbranded or short weight.

Gallo's Brand Salad Oil, No. 43741, packed by I. A. Gallo, Hartford, was cottonseed oil colored with a coal-tar dye. The sample was also short weight, weighing 7.4 pounds to the gallon, whereas the weight per gallon calculated from the specific gravity of the oil should have been 7.64 pounds. In terms of volume the sample represented .97 of a gallon instead of a full gallon as labelled.

Olive oil in bulk, bought of the Roma Importing Co. of Waterbury, consisted in part of cottonseed oil.

Olive oil, Italia brand, bougbt of Gelgrego, New Haven, was also adulterated with cottonseed oil.

El Toro brand olive oil, International Importing Co., Hartford, contained cottonseed oil, as did also the same brand sold by S. Garofalo of Hartford.

Azrite brand olive oil purchased of J. Romas, Ansonia, said to have been supplied by Almeida and Co., of New Bedford, Mass., was adulterated with peanut oil.

Two unofficial samples for investigational purposes were found to contain cottonseed oil.

SPECIAL AND MISCELLANEOUS FOODS

In Table II are analyses of 54 special and miscellaneous foods. Some of these are for diets in which a minimum of carbohydrate is desired, as in certain cases of diabetes. In diabetes it is possible to provide suitable diets from natural foods of known composition but special foods are admissible and sometimes desirable to provide variety or attractiveness in the diet. Insulin treatment is resorted to when the minimal amount of carbohydrate cannot be given without the appearance of glycosuria. In any case a considerable excess of carbohydrate should be avoided and in this connection it must be kept in mind that 50 per cent of the protein may be converted into sugar. Some restriction in protein intake is therefore essential. Those so-called diabetic foods that do not differ from ordinary foods in digestibility offer no specific advantage in diabetic diets and must be eaten with the same precautions as are ordinary foods of like composition.

Flour of cooked chestnuts is a product of French manufacture. It does not appear to be made from the whole, cooked, dry chest-

nut (excluding shell). Comparison of this analysis with that of fresh chestnuts on the same water basis indicates that in the process of manufacture of the flour some of the nitrogenous and fatty portions of the nut are removed and that the starch is proportionately increased.

The *S.M.A.* preparations are specially designed for the feeding of infants. The significance of the symbol S.M.A. is "synthetic milk adapted." All of the preparations are directed to be fed on the advice and under the supervision of a physician.

Similac is another modified milk preparation intended for infant feeding also under the direction of a physician.

Nouron is not a milk substitute but is rather intended for children at the period when they are passing from wholly liquid to partially solid diet. It is made from soy beans, whole wheat flour and egg yolk.

The three algae samples, 3141, 3142 and 3143, were analyzed for a student of Iowa State College who is interested in them from a nutritional standpoint. Only one of them, 3141, is a commercial product.

"Fiddle heads," so-called, are a species of native ferns said to have been used by the Indians as food.

The soybean products, 2347, 2683 and 2682, were submitted by the Madison Rural Sanitarium in connection with its experimental studies in dietetics.

No.	Kind	Water	Ash	Protein (Factor 6.25)	Fiber	Carbohydrate: Starch + Water-soluble calculated as dextrose	Carbohydrate: Undetermined	Fat
	Groult, Jor, Paris	%	%	%	%	%	%	%
3010	Flour of Cooked Chestnuts	6.30	2.00	6.63	2.05	65.28	14.76	2.98
	Kings County Packing Co., Armona, Cal.							
837	Sac-A-Rin Brand, California Muscat Grapes	92.80	0.38	0.63	0.41	13.73[1]	....	....
838	Sac-A-Rin Brand, California Seedless Grapes	82.80	0.38	0.63	0.20	15.23[1]	....	....
841	Sac-A-Rin Brand, California Spinach	93.19	0.99	2.31	0.68	0.49[2]	....	....
840	Sac-A-Rin Brand, California Kadota Figs	83.79	0.49	0.50	0.51	13.02[1]	....	....
339	Sac-A-Rin Brand, California Yellow Cling Peaches	92.11	0.32	0.56	0.34	5.18[1]	....	....
	The Laboratory Products Co., Cleveland, Ohio							
3206	S. M. A.	2.28	2.51	10.44	none	57.67		27.10[3]
3207	S. M. A. Protein (Acidulated)	3.95	5.98	32.44	none	39.35		18.28[3]
3208	S. M. A. (Concentrated)	71.50	0.66	3.06	0.85	16.33		7.60[3]
	Loeb Dietetic Food Co., New York City							
2083	Loeb's Gluten Cracker Meal	8.57	1.64	41.78[4]	0.39	34.19	3.72	9.71
2084	Loeb's Gluten Zwieback	7.83	3.29	43.09[4]	0.46	34.44	4.26	6.63
2085	Loeb's Gluten Zwieback-Almond	7.76	2.97	42.52[4]	0.53	34.13	2.93	9.16
2086	Loeb's Gluten Bread Sticks	9.55	3.50	42.58[4]	0.76	35.88	1.30	6.43
2087	Loeb's Gluten Almond Bread Sticks	9.15	3.40	37.73[4]	0.96	29.00	5.49	14.27
2088	Loeb's Genuine Gluten Bread—Sliced and Toasted	7.61	5.71	43.78[4]	0.38	35.25	0.88	6.39
2089	Loeb's Gluten Breakfast Cereal	6.18	3.12	37.28[4]	0.98	27.44	8.07	16.93
2090	Loeb's Aerated Gluten Rolls	7.74	1.16	44.29[4]	0.25	35.81	2.11	8.64
2091	Loeb's Genuine Gluten Bread	24.93	2.45	35.81[4]	0.36	28.20	3.15	5.10
2092	Loeb's Self-Rising Gluten Flour	8.74	6.85	38.13[4]	0.25	40.44	4.04	1.55

[1] Calculated as invert sugar. Contains saccharin.
[2] Contains no saccharin.
[3] Roese-Gottlieb Method.
[4] Factor 5.7.

TABLE II. SPECIAL AND MISCELLANEOUS FOODS—*Continued.*

No.	Kind	Water	Ash	Protein (Factor 6.25)	Fiber	Carbohydrate		Fat
						Starch + Water-soluble calculated as dextrose	Undetermined	
	Loeb Dietetic Food Co., New York City—Con.	%	%	%	%	%	%	%
2093	Loeb's Lady Fingers	8.25	4.61	49.65	0.38	6.31	3.69	27.11
2094	Loeb's Dietetic Bran Wafers	6.71	4.73	26.00	10.65	2.06	30.81	19.04
2095	Loeb's Plain Gluten Noodles—Fine	9.43	1.61	39.56[4]	0.44	41.75	1.15	6.06
2096	Loeb's Plain Gluten Noodles—Broad	6.42	1.18	40.01[4]	0.32	44.19	0.00	7.88
2097	Loeb's Pure Gluten Flour	9.67	1.08	41.50[4]	0.29	42.88	2.99	1.59
2098	Loeb's Gluten Butter Cookies	7.18	2.63	37.56[4]	0.49	29.65	4.31	18.18
2099	Loeb's Gluten Crackers	7.05	2.71	35.34[4]	0.46	30.50	4.06	19.88
2100	Loeb's Sponge Cookies	8.90	4.14	53.81	0.40	4.81	3.77	24.17
2101	Loeb's Almond Macaroons	5.29	5.15	29.88	5.98	4.75	8.62	40.33
2102	Loeb's Starch Free Bran	8.38	4.89	17.75	16.57	2.81	41.24	8.36
2103	Loeb's Gluten Egg Barley	9.60	1.26	42.41[4]	0.67	36.31	1.26	8.49
2104	Loeb's Dietetic India Gum	15.88	5.42	0.63	....	....	77.82	0.25
2105	Loeb's Cocoa and Casein	6.21	4.46	35.63	3.75	12.63	20.24	17.08
2107	Loeb's Aerated Gluten Bread	8.28	1.06	44.86[4]	0.45	35.13	1.49	8.73
2108	Loeb's Dietetic Chocolate Bars	6.28	3.10	14.25	3.27	9.25	14.19	49.43
2109	Loeb's Chocolate Almond Bars	5.08	3.06	15.13	4.68	8.75	12.78	50.52
	Madison Health Foods, Madison, Tenn.							
1153	Malta	25.81	0.41	....	....	72.40		....
1150	Nut Meat	53.68	2.04[5]	14.38	0.44	7.77		21.69
1151	Nut Roast with Tomato	58.33	1.76[6]	11.19	0.84	12.71		15.17
1152	Vegetarian Meat	58.70	2.38[7]	14.13	1.22	7.67		15.90
	Mellin's Food Co. of North America, Boston, Mass.							
3210	Mellin's Food	2.20	3.90	10.63	none	81.54		1.73[3]

[3] Roese-Gottlieb Method.
[4] Factor 5.7.
[5] NaCl 0.94%.
[6] NaCl 0.81%.
[7] NaCl 1.30%.

TABLE II. SPECIAL AND MISCELLANEOUS FOODS—*Concluded.*

No.	Kind	Water	Ash	*Protein* (Factor 6.25)	Fiber	Carbohydrate: Starch + Water-soluble calculated as dextrose	Carbohydrate: Undetermined	Fat
	M & R Dietetic Laboratories, Inc., Columbus, Ohio	%	%	%	%	%	%	%
3204	Similac	2.45	4.04	12.50	none	55.46		25.55[3]
	Nestle's Food Co., Inc., New York City							
3205	"Lactogen"—"Milk for Babies"	3.10	3.48	16.38	none	52.34		24.70[3]
3209	Nestle's Milk Food	3.25	2.57	14.38	0.60	69.85		9.35[3]
	Nouron Products Corp., New York City							
3280	Nouron	8.30	2.48	24.38	3.05	52.46		9.33
	Vitae Health Food Co., Seattle, Wash.							
2272	Blended Dietetic Bran (Starch Free)	8.33	4.50	14.75	22.05	9.63[8]	35.57	5.17
2273	"Soya Manna"	8.05	4.68	42.13	2.00	10.25[9]	12.42	20.47
	Miscellaneous							
3141	"Flour of Algae," Thyodine Chemical Co., Washington, D. C.	7.48	35.62[10]	5.38	7.43	43.46		0.63
3142	Laminaria Sp., from Osaka, Japan	5.95	23.83[11]	6.56	5.15	57.78		0.73
3143	Algae, Undaria Pinnatifida, from Kobe, Japan	6.95	34.50[12]	12.38	3.40	42.02		0.75
1893	Fiddle Heads, *Osmunda cinnamomea*	87.03	1.24	4.72	1.04	5.56		0.41
3539	Jeru Artichoke Soup, Pabst Dietary Products, Inc., Milwaukee, Wis.	73.92	6.50	2.25	0.75	16.55		0.03
2437	Soy Cheese, Madison Rural Sanitarium, Madison, Tenn.	77.20	0.55[13]	14.44	....	trace	4.31	3.50
2683	Soy Milk, raw, Madison Rural Sanitarium, Madison, Tenn.	91.29	0.48	4.94	....	0.92[14]	0.88	1.49
2682	Soy Milk, boiled, Madison Rural Sanitarium, Madison, Tenn.	94.54	0.42	2.25	....	0.96[14]	0.91	0.92

[3] Roese-Gottlieb Method.
[8] Starch, qualitative, present.
[9] Starch, qualitative, trace
[10] Total P_2O_5 0.60%; Fe_2O_3 0.24%; CaO 1.75%; Iodine 0.15%.
[11] Total P_2O_5 0.67%; Fe_2O_3 0.04%; CaO 1.48%; Iodine 0.36%.
[12] Total P_2O_5 0.97%; Fe_2O_3 0.07%; CaO 1.34%; Iodine 0.03%.
[13] NaCl, trace.
[14] Starch, qualitative, none.

FRUIT PRODUCTS

CIDER

Five samples were examined. Three contained benzoate of soda. Two were products not offered for sale but represented stock for the manufacture of vinegar.

GRAPE FRUIT JUICE

Two samples of grape fruit juice, Florida Gold Brand and Taylor's, were submitted by the Dairy and Food Commissioner. They contained respectively 17.80 and 18.67 per cent of solids, 15.12 and 15.25 per cent of sugar (as invert sugar), and 0.37 and 0.35 per cent of ash. No preservative was found.

GRAPE JUICE, ETC.

A sample of grape juice, white, 42496, submitted by the Dairy and Food Commissioner, was examined. It was Giltedge brand, sold by The Walter Stewart Co., Ridgefield. Treatment with sulfur dioxide and the addition of cane sugar in the form of a water solution were declared. Sulfur dioxide was found in the amount of 120 milligrams per liter. There was 18.6 per cent of invert sugar present, 0.5 per cent of sucrose and a total sugar content of 19.1 per cent. It was estimated that about 16 per cent of water and 4 per cent of sugar had been added.

Two other samples of grape juice, red, were examined for experimental purposes. Unsweetened juice contained 13.41 per cent of invert sugar and the same juice sweetened contained 17.8 per cent.

A sample of grape-flavored syrup contained 65.15 per cent of invert sugar and a sample of grape soda made from this syrup contained 14 per cent of invert sugar.

JAMS AND JELLIES

Eleven samples were tested for preservatives and for saccharin but no evidence of either substance was obtained.

HONEY

Three unofficial samples of honey were examined and all found to be within the limits of composition of pure honey.

ICE CREAM, ETC.

Three hundred and one samples of ice cream and 17 samples of so-called frozen custard were submitted by the Commissioner. One unofficial sample of ice cream, two of ice cream mix and two of frozen custard were also examined for producers.

The State standard for fat content in plain ice cream is 8 per cent and for fruit and nut ice cream 6 per cent. Ice cream may be manufactured and sold, however, containing less than the above percentages of fat, provided proper declaration of the actual fat content is made. Experience has shown that there is very little inclination to market the substandard article under any circumstances. Only four samples below eight percent were found this year.

A Federal standard proposed several years ago fixing the fat content for plain ice cream at 12 per cent has never become official. The multiplicity of standards obtaining in the several states makes the adoption of a satisfactory Federal standard difficult, and perhaps it is unnecessary. The manufacturer who ships ice cream into several States may be embarrassed at times by conflicting State standards, but he will encounter the same difficulty under a Federal standard unless the States choose to revise their present laws and regulations to conform therewith.

A summary of the inspection of official samples is here given, and the results in detail appear in Table III.

Per cent of fat	No. of samples	Per cent of total
8.0 to 9.9	31	10.3
10.0 to 11.9	82	27.2
12.0 and above	184	61.1
7.9 and below	4	1.4
Total	301	100.0

TABLE III. ANALYSES OF ICE CREAM

No.	Flavor	Dealer	Manufacturer	Fat
		Ansonia		%
40647	Vanilla	J. Casagrande	Own make	8.4
40648	Vanilla	C. M. Georges	Own make	12.0
42594	Vanilla	Purity Tea Room	Own make	10.8
42593	Vanilla	Stever's North End Drug Store	Own make	14.4
40649	Vanilla	Venetas Bros.	Own make	11.8
42700	Strawberry	Venetas Bros.	Own make	11.2
		Branford		
40617	Vanilla	Branford Candy Shoppe	Tait Bros., New London	11.2
40618	Strawberry	Branford Candy Shoppe	Tait Bros., New London	9.0
41180	Vanilla	L. G. Shmouny	Harris-Hart, New Haven	10.6
		Bridgeport		
42821	Vanilla	Athens Confectionery Co.	Own make	14.8
42730	Vanilla	Atlantic Confectionery Co.	Own make	17.6
42824	Vanilla	Boston Candy Co.	Own make	14.2
42825	Vanilla	Bridgeport Lemon Ice Co.	Own make	10.4
42747	Vanilla	Candyland	Own make	13.0
42828	Vanilla	George Casteines	Own make	8.4
42733	Vanilla	Downy Flake Doughnut Shop	Mitchell Dairy Co., Bgpt.	17.0
42734	Orange-pineapple	Downy Flake Doughnut Shop	Mitchell Dairy Co., Bgpt.	13.2
42827	Vanilla	S. Gerstl	Own make	10.4
42732	Vanilla	Goodie Chocolate Shop	Own make	16.8
42736	Vanilla	Kozy Corner Store	Huber's, Bgpt.	13.2
42737	Strawberry	Kozy Corner Store	Huber's, Bgpt.	11.4
42731	Vanilla	Lane's	Own make	13.0
42830	Vanilla	Newfield Candy Co.	Own make	12.0
42748	Vanilla	Paradise Confectionery Co.	Own make	13.2
42735	Vanilla	Park City Spa	Own make	14.8
42829	Vanilla	Vincent Rossi	Own make	8.2
42826	Vanilla	Royal Candy Co.	Own make	11.0
42746	Vanilla	Strand Confectionery Co.	New Haven Dairy	12.0
42729	Vanilla	Venus Confectionery Co.	Own make	12.8
42822	Vanilla	Villari's Pharmacy	Park City I. C. Co., Bgpt.	13.6
42823	Strawberry	Villari's Pharmacy	Park City I. C. Co., Bgpt.	10.8
42728	Chocolate	J. Wakins	Huber's, Bgpt.	12.0
		Bristol		
41199	Vanilla	Central Lunch	Palace of Sweets, Plainville	14.4
42554	Vanilla	The Liberty Confectionery Co.	Own make	14.4
42550	Maple-nut	The Main Pharmacy	Eastern Dairies, New Britain	11.0
42551	Strawberry	The Main Pharmacy	Eastern Dairies, New Britain	9.6
41197	Vanilla	The Palace of Sweets	Own make	14.2
42553	Vanilla	The Soda Shoppe	Own make	14.0
41198	Vanilla	Sweetland Confectionery	Own make	14.0
		Brooklyn		
42846	Vanilla	J. W. Albro	Own make	13.2
		Canton		
42755	Vanilla	Margaret Dyer	....	23.6

TABLE III. ANALYSES OF ICE CREAM—*Continued*

No.	Flavor	Dealer	Manufacturer	Fat
		Collinsville		%
42596	Vanilla	Collinsville Candy Kitchen	Own make	15.8
		Columbia		
42796	Vanilla	Myrtle Collins	Own make	4.3
		Cos Cob		
42814	Vanilla	Mead's Pharmacy	J. M. Horton I. C. Co., N. Y.	15.6
42815	Strawberry	Mead's Pharmacy	J. M. Horton I. C. Co., N. Y.	12.6
42718	Vanilla	Taylor's Store	Breyer's I. C. Co., Phila.	12.8
		Danbury		
42974	Orange-pineapple	Crownland Soda Shop	General I. C. Corp.	8.8
42973	Vanilla	Danbury Candy Co.	Own make	11.6
42972	Vanilla	The Eagle Confectonery	Own make	13.2
42968	Vanilla	Nader and Libbos	Rider's I. C. Co.	13.0
42969	Strawberry	Nader and Libbos	Rider's I. C. Co.	11.2
42970	Vanilla	Palace Confectionery	Chester Hatch's I. C. Co.	12.6
42971	Strawberry	Palace Confectionery	Chester Hatch's I. C. Co.	12.0
		Danielson		
42839	Vanilla	Rexall Pharmacy	Dolbey's Fro-Joy	10.6
42840	Strawberry	Rexall Pharmacy	Dolbey's Fro-Joy	10.6
42841	Vanilla	Woodward Pharmacy	Hood's I. C. Co.	12.6
42842	Strawberry	Woodward Pharmacy	Hood's I. C. Co.	11.2
		Deep River		
40616	Vanilla	Hartford Candy Kitchen	New Haven Dairy	11.6
		Forestville		
42555	Vanilla	The Forestville Soda Shop	Crown I. C. Co.,New Britain	14.6
42556	Strawberry	The Forestville Soda Shop	Crown I. C. Co.,New Britain	10.2
		Greenwich		
42717	Vanilla	Greenwich Candy Shop	Neilsen's, N. Y.	16.4
42715	Vanilla	A. B. Libano Co.	Own make	15.8
42716	Strawberry	A. B. Libano Co.	Own make	12.8
42812	Vanilla	Palm Tea Room	Own make	15.2
42813	Vanilla	Rose Ely Goodie Shop	Own make	16.4
		Groton		
42955	Vanilla	Scuris Bros.	Own make	17.4
42956	Peach	Scuris Bros.	Own make	16.8
		Hartford		
42779	Vanilla	Besse's	Own make	14.8
42780	Peach	Besse's	Own make	15.2
42788	Vanilla	Capitol-Lyric Confectionery	Own make	14.6
41165	Vanilla	Ce Brook Ice Cream Co.	Own make	11.2
41166	Strawberry	Ce Brook Ice Cream Co.	Own make	9.6
41167	Chocolate	Ce Brook Ice Cream Co.	Own make	10.0
42787	Vanilla	Rosario Cippola	Own make	8.8

TABLE III. ANALYSES OF ICE CREAM—*Continued*

No.	Flavor	Dealer	Manufacturer	Fat
		Hartford—Concluded		%
42774	Vanilla	Crown Confectionery	Own make	13.4
42781	Vanilla	Empire Delicatessen	General I. C. Co.	9.8
43525	Vanilla	The Federal Baking Co.	Reid's I. C. Co., N. Y.	11.4
43526	Strawberry	The Federal Baking Co.	Reid's I. C. Co., N. Y.	11.4
42773	Vanilla	G. Fox & Co.	Own make	18.6
42775	Vanilla	Henri's Wooster Shoppe	General I. C. Co.	11.2
42769	Vanilla	Highland Dairy Co.	Own make	12.6
42770	Strawberry	Highland Dairy Co.	Own make	12.6
42771	Vanilla	Jensen's	Own make	17.6
42772	Peach	Jensen's	Own make	14.8
42979	Strawberry	L & B Delicatessen	Ce Brook I. C. Co.	9.0
42980	Chocolate	L & B Delicatessen	Ce Brook I. C. Co.	9.8
43527	Vanilla	Loft, Inc.	Own make	14.2
43528	Strawberry	Loft, Inc.	Own make	11.8
41168	Chocolate	New Haven Dairy	Own make	10.8
41169	Vanilla	New Haven Dairy	Own make	11.4
41170	Strawberry	New Haven Dairy	Own make	9.6
42777	Vanilla	The New Paris	Own make	16.2
42778	Peach	The New Paris	Own make	17.8
42782	Vanilla	Patterson's Candyland	Own make	12.6
42785	Vanilla	Peter's' Soda Shop	Own make	14.6
42786	Strawberry	Peter's' Soda Shop	Own make	15.6
42776	Vanilla	Robbin's, Inc.	Own make	18.2
42789	Vanilla	Royal Candy Kitchen	Own make	10.8
42783	Vanilla	Shelton Lemon Ice Co.	Own make	9.8
42784	Vanilla	South Green Confectionery Co.	Own make	16.2
42754	Coffee	John Stiguel	Semon's	10.6
42790	Country Club Special	Thrall Pharmacy	Ce Brook I. C. Co.	11.0
		Hazardville		
42587	Vanilla	Geo. F. Conley	Hood's I. C. Co.	12.8
		Jewett City		
42849	Vanilla	Fred Maynard	Own make	14.0
		Lakeville		
42960	Vanilla	Leverty's Pharmacy	General I. C. Co.	10.8
42961	Strawberry	Leverty's Pharmacy	General I. C. Co.	10.4
		Lyme		
41179	Vanilla	Hall-Mark Chocolate Co.	....	13.6
		Manchester		
42578	Vanilla	Manchester Candy Kitchen	Manchester Dairy I. C. Co.	15.2
42579	Strawberry	Manchester Candy Kitchen	Manchester Dairy I. C. Co.	12.6

TABLE III. ANALYSES OF ICE CREAM—*Continued*

No.	Flavor	Dealer	Manufacturer	Fat
		Meriden		%
42761	Chocolate	Broderick Pharmacy	....	9.4
42757	Vanilla	Billie Burns Candy Shoppe	Own make	13.8
42759	Vanilla	The Candy Box	Own make	13.8
42760	Vanilla	The Chocolate Shoppe	Own make	15.2
42756	Vanilla	Geo. Hartmann	O. D. Foote's I. C. Co.	14.4
42758	Vanilla	Katt Bros.	Own make	13.2
		Middletown		
40611	Orange-pineapple	Cubeta Bros.	Millbrook Dairy	12.4
40612	Strawberry	Cubeta Bros.	Millbrook Dairy	11.6
41176	Vanilla	Kresge's Dept. Store	Fro-Joy Brand	11.4
41177	Strawberry	Kresge's Dept. Store	Fro-Joy Brand	9.6
40613	Vanilla	Linbrook I. C. Co.	Own make	15.0
40614	Strawberry	Linbrook I. C. Co.	Own make	12.4
41178	Vanilla	Neville's Candy Shop	....	16.2
41174	Vanilla	Olympia Candy Shop	....	14.8
40615	Vanilla	Park St. Pharmacy	Millbrook Dairy	12.6
41175	Vanilla	Stueck & Son	....	15.2
		Montville		
42950	Vanilla	Uncasville Candy Co.	Own make	16.4
		Moosup		
42845	Vanilla	Daggett's Ice Cream Store	Own make	21.8
		Mystic		
42951	Vanilla	Riverside Ice Cream Parlor	Own make	22.2
		Naugatuck		
40645	Vanilla	Naugatuck Dairy Ice Cream Co.	Own make	17.0
40646	Strawberry	Naugatuck Dairy Ice Cream Co.	Own make	9.8
		New Britain		
42981	Vanilla	Blew's Soda Spa	Millbrook I. C. Co.	12.0
42740	Vanilla	Burritt Hotel Soda Shoppe	New Haven Dairy	10.6
42982	Vanilla	Coutaras Bros.	Ce Brook I. C. Co.	11.2
42983	Lemon	Coutaras Bros.	Ce Brook I. C. Co.	11.4
42738	Vanilla	Elmain Garden	New Haven Dairy	11.0
42739	Strawberry	Elmain Garden	New Haven Dairy	9.4
42809	Maple-nut	Kaufman's Store	Nelson's Purity, Inc.	13.8
42804	Vanilla	Star Confectionery	Own make	15.8
42805	Vanilla	St. Clair Confectionery	Own make	15.2
42806	Vanilla	West End Drug Store	Coon's Fro-Joy	11.2
42807	Strawberry	West End Drug Store	Coon's Fro-Joy	8.6
		New Canaan		
42975	Vanilla	Olympia Candy Co.	Own make	16.4
		New Haven		
41183	Vanilla	Basil's Confectionery	....	10.8
42572	Vanilla	Beaver Confectionery	Own make	11.4

TABLE III. ANALYSES OF ICE CREAM—*Continued*

No.	Flavor	Dealer	Manufacturer	Fat
		New Haven—Concluded		%
42573	Vanilla	Boulevard Candy Shop	Own make	12.2
42562	Vanilla	Bouzoucos Bros.	Own make	12.6
42568	Vanilla	De Lupe Bros.	Own make	12.6
40623	Vanilla	Crescent Drug Co.	Semon's	10.8
40624	Strawberry	Crescent Drug Co.	Semon's	9.8
42564	Vanilla	Cummings Bros.	Own make	12.4
40632	Vanilla	Peter Daniels	Own make	9.8
40622	Vanilla	Liberato Dellamura	Own make	9.2
42569	Vanilla	I. Dickstein	Own make	10.0
42571	Vanilla	Edgewood Soda Shoppe	Own make	9.6
41185	Vanilla	D. Felice	....	8.8
41186	Vanilla	Gabriel's Ice Cream Parlor	....	11.0
42575	Vanilla	Garden Drug Store	Sagal-Lou I. C. Co.	11.4
42576	Strawberry	Garden Drug Store	Sagal-Lou I. C. Co.	9.6
41187	Vanilla	Grand Confectionery Co.	....	10.0
42565	Vanilla	John Gilbert & Son	Own make	11.4
42566	Vanilla	House of Hasselbach	Own make	13.4
41196	Vanilla	Howard Ice Cream Parlor	....	13.6
42577	Vanilla	Huntington Confectionery	Own make	10.8
42563	Vanilla	Kum-On-Inn Shop	Own make	9.8
42741	Brick	Liggett's' Drug Store	Consolidated Dairy Products Co., Long Island City, N. Y.	10.2
41188	Strawberry	L. Liscio	Harris-Hart	12.4
40621	Vanilla	Olympia Candy Kitchen	Own make	10.6
41184	Vanilla	Original Olympia Candy Co.	....	10.0
40625	Vanilla	Palace of Sweets	....	12.4
40626	Strawberry	Palace of Sweets	New Haven Dairy	9.6
40619	Vanilla	Polos Confectionery Co.	Own make	10.4
40620	Orange-pineapple	Polos Confectionery Co.	Own make	9.4
41189	Chocolate	Polos Confectionery Co.	Own make	7.4
42567	Vanilla	Mrs. Root's Food Shop	Own make	11.6
42976	Vanilla	The Smoke Shop	Brock-Hall Co.	14.0
42977	Strawberry	The Smoke Shop	Brock-Hall Co.	12.8
42570	Vanilla	Sweetland Confectionery Co.	Own make	10.8
41181	Vanilla	Peter Villani	....	10.6
41182	Peach	Peter Villani	....	9.0
42574	Vanilla	Westville Confectionery Co.	Own make	10.6
		New London		
41172	Vanilla	Boston Candy Kitchen	Own make	16.8
40608	Vanilla	Conti Bros.	Own make	19.6
40601	Vanilla	Capitol Candy Kitchen	Own make	15.2
40602	Vanilla	Garde Catering Co.	Own make	18.8
40610	Vanilla	Liberty Candy Kitchen	Own make	16.6
40605	Vanilla	A. J. Maloof	Own make	12.4
40606	Orange-pineapple	A. J. Maloof	Own make	10.8
40607	Vanilla	A. J. Maloof	Own make	11.8
40603	Vanilla	Mohican Hotel Candy & Soda Shoppe	Own make	22.0

TABLE III. ANALYSES OF ICE CREAM—*Continued*

No.	Flavor	Dealer	Manufacturer	Fat
		New London—Concluded		%
40600	Vanilla	John Nichols	Own make	19.8
41171	Vanilla	Petersen's Tea Room	Own make	20.0
40609	Vanilla	G. P. Photos	Own make	13.2
40604	Strawberry	Victory Candy Shop	Own make	16.2
41173	Vanilla	M. Y. Vong's Sweet Shoppe	Own make	14.4
		New Milford		
42962	Vanilla	Arthur Bona	Own make	13.6
42963	Vanilla	Hipp's Ice Cream Store	Own make	12.8
42964	Orange-pineapple	Hipp's Ice Cream Store	Own make	12.8
42965	Vanilla	George Nichols	Own make	11.2
42966	Orange-pineapple	Park Pharmacy	Fro-Joy Brand	10.2
42967	Vanilla	Park Pharmacy	Fro-Joy Brand	11.0
		Niantic		
42959	Vanilla	Arthur Lockwood	Own make	10.4
		Norwalk		
42725	Vanilla	Golden's	Own make	14.8
42727	Vanilla	Main Confectionery Co.	New Haven Dairy, Bgpt.	11.2
42726	Vanilla	Peter's Sweet Shop	Own make	14.4
42820	Vanilla	Thomas Soda Shop	Own make	19.2
		Norwich		
42711	Vanilla	The Arcadia	Own make	17.6
42803	Strawberry	G. Lacahera	A. J. Maloof, New London	10.6
42709	Vanilla	Norwich Dairy Ice Cream Co.	Own make	15.4
42710	Strawberry	Norwich Dairy Ice Cream Co.	Own make	14.6
42708	Vanilla	Olympia Candy Kitchen	Own make	12.6
42714	Vanilla	Pitcher & Service	Dairymaid Ice Cream Co., Worcester, Mass.	13.8
42801	Vanilla	Sellas Spa	Own make	17.2
42802	Strawberry	Sellas Spa	Own make	15.4
42800	Vanilla	The Terminal Restaurant	Own make	17.8
42712	Vanilla	C. C. Treat	Own make	17.4
42713	Orange-pineapple	C. C. Treat	Own make	18.6
		Pawcatuck		
42953	Vanilla	Greek-American Co.	Own make	26.0
		Plainfield		
42847	Vanilla	The Maples	Kelly's	13.4
42848	Peach	The Maples	Kelly's	11.0
		Plainville		
42808	Vanilla	Kaufmann's Store	Nelson's Purity Ice Cream Co.	14.0
		•		
42558	Strawberry	The Palace of Sweets	Own make	14.4
42557	Strawberry	Rialto Soda Shop	Ce Brook Ice Cream Co.	8.8

TABLE III. ANALYSES OF ICE CREAM—*Continued*

No.	Flavor	Dealer	Manufacturer	Fat,
		Plainville—Concluded		%
42559	Vanilla	The Thrall Pharmacy	R. H. Worden & Sons Co., Waterbury	13.4
42560	Strawberry	The Thrall Pharmacy	R. H. Worden & Sons Co., Waterbury	12.0
		Pomfret		
42831	Vanilla	Allard's	Own make	30.0
		Putnam		
42838	Coffee	D. Allard	Fro-Joy Brand	11.0
42836	Strawberry	W. B. Carroll, Rexall Drug Store	Turner Center I. C. Co.	11.6
42837	Vanilla	Olympia Candy Co.	Own make	20.2
42835	Vanilla	Progress Confectionery Co.	Own make	14.8
42832	Vanilla	United Cigar Stores	Crown Quality I. C. Co.	14.6
42833	Strawberry	United Cigar Stores	Crown Quality I. C. Co.	13.8
		Rockville		
40634	Vanilla	S. H. Conners	Tait Bros., Spfld.	10.8
40633	Vanilla	John E. Gawtrey	Own make	13.0
42582	Vanilla	Peter's Chocolate Shop	Own make	14.4
		Seymour		
42592	Vanilla	Kalardis Bros.	Own make	10.4
		Shelton		
42595	Vanilla	E. J. Barton	Own make	15.4
		Somers		
40638	Chocolate	Mrs. Herbert N. Kibbe	Hood's I. C. Co.	14.4
42585	Vanilla	Somers Tea Room	Turnbull's I. C. Co.	15.0
42586	Strawberry	Somers Tea Room	Turnbull's I. C. Co.	13.8
		Southington		
42561	Vanilla	The Candy Shoppe	Own make	12.0
		South Manchester		
42580	Vanilla	The Coffee Shoppe	C. C. Treat I. C. Co.	17.2
42581	Strawberry	The Coffee Shoppe	C. C. Treat I. C. Co.	16.4
		South Norwalk		
42724	Vanilla	The Mahackamo	Own make	15.0
42819	Vanilla	Palace Confectionery	Own make	12.6
		Stafford Springs		
40635	Vanilla	Louis Campo	Own make	14.4
40636	Strawberry	Louis Campo	Own make	13.6
42583	Vanilla	P. J. Murray	Own make	14.4
40637	Vanilla	E. J. Parizean	Own make	17.2
42584	Chocolate	Stafford Candy Kitchen	Fro-Joy Brand	11.0

TABLE III. ANALYSES OF ICE CREAM—*Continued*

No.*	Flavor	Dealer	Manufacturer	Fat,
		Stamford		%
42810	Vanilla	Maplehurst Dairy Co.	Own make	16.0
42811	Strawberry	Maplehurst Dairy Co.	Own make	15.2
42719	Vanilla	Massoletti's	Own make	14.6
42720	Peach	Massoletti's	Own make	9.8
42721	Vanilla	Olympia Candy Shop	Own make	12.6
42818	Vanilla	Stamford Health Food Store	Rider's I. C. Co.	13.0
42723	Vanilla	Star Confectionery Co.	Own make	16.0
42722	Vanilla	Strand Confectionery Co.	Own make	15.6
42817	Vanilla	Whelan's Drug Store	Cons. I. C. Co., N. Y.	14.8
		Thompson		
42834	Coffee	Vernon Stiles Inn	Own make	12.8
		Thompsonville		
42588	Vanilla	A. Tatoian	Own make	15.2
		Torrington		
42597	Vanilla	Allen Candy Co.	Own make	11.6
42751	Vanilla	Jacob's Bros.	Own make	14.4
42752	Strawberry	Jacob's Bros.	Own make	13.6
42598	Vanilla	Olympia Candy Kitchen	Own make	14.6
42599	Vanilla	Rexall Drug Store	Torrington Creamery Co.	11.2
42750	Strawberry	Rexall Drug Store	Torrington Creamery Co.	11.2
		Wallingford		
42763	Chocolate	O. D. Foote	Own make	13.4
42764	Peach	O. D. Foote	Own make	13.2
42762	Vanilla	J. H. Griffin	Own make	15.0
42766	Vanilla	A. Pappas	Own make	12.0
42767	Chocolate	A. Pappas	Own make	12.6
42765	Vanilla	The Sugar Bowl	Own make	15.2
		Wauregan		
42844	Vanilla	H. J. Fournier	Own make	13.4
42843	Vanilla	Mrs. A. J. Hope	Fro-Joy Brand	14.4
		West Haven		
40631	Vanilla	Big Y Drink Stand, Savin Rock	....	3.8
41191	Vanilla	Cameo Confectionery Co.	....	11.4
42791	Vanilla	A. Goldman, Savin Rock	Clark's Dairy	10.2
42792	Strawberry	A. Goldman, Savin Rock	Clark's Dairy	8.8
40628	Vanilla	Goraieb Co., Savin Rock	Sagal-Lou Co.	10.6
41195	Vanilla	R. R. Grove Midway, Savin Rock	Clark Dairy	11.0
41190	Vanilla	Thompson's Spa	....	13.4

TABLE III. ANALYSES OF ICE CREAM—*Concluded*

No.	Flavor	Dealer	Manufacturer	Fat
		Waterbury		%
40642	Vanilla	The Allen Candy Shop	Own make	14.2
40641	Vanilla	The Candy Shoppe	New Haven Dairy	10.6
40643	Vanilla	A. Magi	Whelan's I. C. Co.	11.2
40644	Pineapple	A. Magi	Whelan's I. C. Co.	10.0
42591	Strawberry	Martin's Pharmacy	R. F. Worden & Sons Co.	11.6
42590	Vanilla	Martin's Pharmacy	R. F. Worden & Sons Co.	13.2
42589	Vanilla	Puritan Tea Room	Own make	16.4
		Westerly		
42954	Vanilla	George Bailey	Maine I. C. Co.	16.2
		Willimantic		
42797	Vanilla	C. J. Albro	Own make	19.0
42799	Vanilla	Bay State Pharmacy	Hood's I. C. Co.	13.2
42706	Vanilla	Hallock's, Inc.	B. C. Hallock	14.6
42707	Strawberry	Hallock's, Inc.	B. C. Hallock	13.6
42705	Vanilla	Michael Longo	Bushway I. C. Co.	12.4
42798	Vanilla	Thread City Candy Kitchen	Own make	13.8
		Windsor Locks		
40639	Vanilla	DeFocie Bros.	Somers Creamery Co., Spfld.	12.8
40640	Strawberry	DeFocie Bros.	Somers Creamery Co., Spfld.	11.2
		Winsted		
42753	Maple-walnut	Highland Sweet Shop	Torrington Creamery Co.	12.2
		Address Unknown		
42552	Vanilla	Central Drug Co.	Ce Brook I. C. Co.	10.4

MEAT PRODUCTS, ETC.

HAMBURG STEAK

Nineteen samples of hamburg steak were tested for sulfites and four were found to contain amounts ranging from 540 to 2,209 milligrams per kilo.

Salts of sulfurous acid are not permissible admixtures in meat products. Sulfites cause a reddening of the meat tissue, which makes it appear fresh longer than it would without such treatment. Moreover, they conceal the odor of decomposition without materially checking the decomposition process, wherein lies the chief objection to their use.

Meat thus preserved was obtained at the American Market, Bristol, and at the Boston Market and Economy Markets, Meriden.

FRANKFURTS

Nine samples of frankfurts were examined and all but one were misbranded by reason of failure to declare the presence of cereal or other starchy material. Cereal up to 3.5 per cent is allowable provided declaration of its presence is made but more than 3.5 per cent is not permitted even if declared.

Misbranded products were obtained at the Dwan Co., Torrington; the Fairfield Provision Co., Stamford; Eastern Provision Co., Public Market, International Market, and Frank Luzzi, all of Hartford; Stevens and Roth, Bristol; and William Stange, Meriden.

The prevalence of misbranded frankfurts is not to be judged by the large proportion shown by the data here recorded. The inspector makes qualitative tests and brings only suspicious samples to the laboratory.

Fifteen unofficial samples were also examined.

PORK SAUSAGE

Twenty samples of pork sausage were submitted by the Commissioner. One was misbranded because of an excessive amount (4.5 per cent) of starchy material.

Moisture and nitrogen were determined in order to get indications of excessive water. It has been found by comprehensive study that water in the meats commonly used in sausage making does not exceed 25 times the nitrogen (or four times the protein, using the factor 6.25) content. In three instances the application of this formula indicated excessive moisture in amounts ranging from 6.5 to 11 per cent.

MEAT LOAF SEASONING

Mumsie-Mix, 40927, submitted by the Commissioner, appeared upon examination to consist essentially of corn starch, salt and various spices such as sage, red pepper, mustard, etc. It is a seasoning mixture.

MILK, AND MILK PRODUCTS

MARKET MILK

One hundred and twelve official samples of milk were submitted by the Dairy and Food Commissioner.

The summary of the inspection shows a considerable proportion of samples adulterated by skimming. This is because a survey was made of places where milk was found being dispensed by the glass rather than in bottles. Adulterated samples are listed in Table IV.

Summary of Inspection

	No. of samples	Per cent
Not found adulterated	50	44.6
Adulterated by watering	5	4.5
Adulterated by skimming	31	27.7
Below standard:		
in solids and solids-not-fat	10	8.9
in solids and fat	7	6.3
in solids, fat and solids-not-fat	9	8.0
Totals	112	100.0

In addition to official samples submitted by the Commissioner, 53 samples were tested for consumers and producers.

CHOCOLATED SKIMMED MILK

Four samples of chocolate-skimmed milk products were examined and found to contain from 0.6 to 1.8 per cent of fat.

BUTTERMILK

One sample of semi-solid buttermilk was examined for a purchaser. It contained 27.4 per cent of solids.

EVAPORATED MILK

One sample was examined. It contained 25.7 per cent of solids and 8 per cent of fat, the sum of solids and fat being 33.7. This meets the State standard for products of this type.

POWDERED WHOLE MILK

A sample of Klim Powdered Whole Milk, made by the Borden Co., was analyzed as follows:

Moisture	1.98%
Ash	5.99
Protein (N x 6.38)	25.64
Sugar (by difference)	38.41
Fat	27.98

CREAM

Two samples of cream were tested. One of them was suspected of containing preservative, but no evidence of such substances was found.

TABLE IV. ADULTERATED MILK

No.	Dealer	Solids	Fat
	Containing Added Water	%	%
	Bantam		
40656	Perry Howland	7.11	2.3
40657	Perry Howland	6.91	2.3
	Bridgeport		
43117	Geo. Pappas	11.00	3.6
43144	H. Kiekel	10.58	2.9
	Falls Village		
43365	Mrs. Francis Malnati	9.92	2.7
	Skimmed Milk		
	Ansonia		
43069	P. Haggis	10.70	1.9
43066	Angelo Musante	10.98	2.2
43065	J. K. Wislocki	10.35	1.6
	Branford		
42889	Branford Pharmacy	10.08	1.4
42888	Michael Torello	11.63	2.7
	Bridgeport		
43140	Joseph Cuneo	10.54	1.8
43125	Abraham Erger	9.68	1.5
43139	P. Fancuilli	10.22	1.7
43136	D. Fialk	9.75	1.6
43123	James Forskrotes	9.62	1.2
43118	H. Freudenbein	8.99	0.7
43133	Louis Garabaldi	9.70	1.1
43135	Andrew Genci	10.81	2.3
42857	R. Gerstl	9.48	0.9
42852	Anthony Gerth	9.24	0.8
43124	Boghoz Laglagian	10.57	2.1
43134	Louis Levy	10.47	2.5
43127	F. Maglione	9.79	1.8
42851	Veronica Miller	10.80	2.5
42850	John Trifon	11.44	2.5
	Danbury		
42886	Danbury Confectionery	10.68	1.9
	Derby		
43072	Debarbieri & Masante	10.96	1.9
	East Haven		
42890	M. Levine	10.10	1.6

TABLE IV. ADULTERATED MILK—*Concluded*

No.	Dealer	Solids	Fat
	Skimmed Milk—*Concluded*	%	%
	New Canaan		
42866	Olympia Candy Co.	10.93	2.5
	New Haven		
42868	A. Gabriela	11.10	2.6
42867	A. Wolfson	10.74	2.0
	Ridgefield		
42876	G. A. Mignerey	12.05	2.2
	Waterbury		
43059	Frank Carissimi	11.04	2.4
43055	Kenyon's Hillside Pharmacy	9.55	0.9
43053	W. L. Costen	11.13	2.5
43050	A. Rizk & Son	10.20	1.6

CIDER VINEGAR

The law requires that vinegar (cider vinegar) shall contain not less than 1.6 per cent of solids and not less than four per cent of acidity. The Federal standard has been revised so that the only numerical standard is that for acid strength, viz., four per cent. Since it is now known that genuine vinegar may sometimes contain less than 1.6 per cent of solids it may be unfair to adhere strictly to that limit.

In the inspection carried on by the Commissioner during the past year cider vinegar was called for in all cases.

Three hundred and forty samples were submitted for examination. In most cases products of the substance and quality asked for were obtained as judged by acid strength, solids and other characters.

Forty-five samples were clearly not cider vinegar as shown by negative or faint Hortvet tests and by low solids, generally of a magnitude between 0.2 and 0.6 per cent, which characterize molasses or syrup vinegars. These were purchases of vinegar in bulk.

Nineteen were considerably deficient in acid strength.

Twenty were of legal acid strength but did not meet the required 1.6 per cent of total solids. With some tolerance many of these could probably be passed without serious objection. There were a number, however, showing solids of about one per cent which

were regarded with suspicion. One of these was examined in more detail, the analysis being compared with recorded analyses of genuine vinegar and with vinegar diluted with water. The composition of the suspected sample corresponded to that of a reduced vinegar but the manufacturer gave assurance that it had not been diluted. It was explained that the vinegar in question represented a mixture of genuine vinegars from vinegar stocks of several different years. Analyses of these component vinegars showed substantially the same composition as that of the finished product as regards potential acidity and other characters. The only sample of vinegar stock available for examination had no direct connection with the suspected vinegar, as it represented the product of another season. However, its potential acidity was very different (higher) from that of the vinegar in question, and other values were within the limits of recorded analyses for vinegar stock.

The examination of further samples from this source with more exact histories seemed desirable before reaching final conclusions about this particular product.

In addition to samples examined for the Commissioner, five were analyzed for producers or purchasers.

The total, including samples for investigational purposes, is 351.

DRUGS

Contrary to the usual practice, the drugs examined this year have been taken chiefly from general stores in smaller towns where drugs may be dispensed, if they are sold in original containers and bear the label of a licensed pharmacist, as provided by the regulations of the State Board of Pharmacy. It was thought that the quality of such drugs might be inferior by reason of deterioration due to less rapid turnover of stock. Whether or not this is a reasonable hypothesis, such stocks are, of course, subject to inspection on the same basis as drugs sold in larger establishments in cities.

The results of this inspection show that the proportion of drugs found to be below standard is not greater than that observed when inspection is confined to larger dispensing centers. The proportion is almost exactly the same as was found in the inspections of the two immediately previous years when inspections were confined to larger towns and cities of the State.

It is true, of course, that drugs found on sale in general stores are in all cases products of the same manufacture as are found on the shelves of wholesale and retail druggists, and the results, so far as can be learned from these data, do not indicate that drugs purchased in general stores in country towns are any more likely to be substandard than are the same articles purchased in the city drug store.

AROMATIC SPIRITS OF AMMONIA

According to the formula for the preparation of this article the finished product should contain 1.84 gms. of ammonia (NH_3), in each 100 cc. of solution. The alcoholic strength should be from 62 to 68 per cent by volume.

Seven samples were examined, four of which were of the quality and strength required, and three were somewhat deficient in ammonia.

TABLE V. ASSAY OF AROMATIC SPIRITS OF AMMONIA

No.	Dealer	Manufacturer	Ammonia, gms/100 cc.	Alcohol by vol. %
	Columbia			
42934	H. W. Porter	Charles Osgood Co., Norwich	1.88	63.20
	Cornwall Bridge			
42947	H. W. O'Dell	C. W. Whittlesey Co., New Haven	1.85	64.40
	East Berlin			
42911	Robert Cole	Sisson Drug Co., Hartford	1.42	69.85
	Granby			
42907	H. L. Cowles	Williams & Carlton Co., Hartford	1.99	68.00
	Moodus			
43709	W. J. Thomas & Son	Sisson Drug Co., Hartford	1.54	70.05
	Southington			
43736	E. W. Ferguson	United Chemists, Jersey City	1.48	62.35
	Thompsonville			
43717	David Dixon	Superba Products Co., Boston	1.84	64.55

LIME WATER

Solution of calcium hydroxide (lime water) should contain not less than 0.14 gm. of calcium hydroxide at 25° C. It will contain about 0.17 gm. at 15° C., the amount diminishing as the temperature rises.

The five samples examined were all of standard quality.

TABLE VI. ASSAY OF LIME WATER

No.	Dealer	Manufacturer	Calcium hydroxide, gms/100 cc.
	Cobalt		
43706	Ed. Elkin	Williams & Carlton Co., Hartford	0.17
	Moodus		
43710	W. J. Thomas & Son	Sisson Drug Co., Hartford	0.16
	Northford		
43728	Johnson Bros.	Williams & Carlton Co., Hartford	0.15
	North Stonington		
42939	Brown & Stone	Charles Osgood Co., Norwich	0.15
	Thompsonville		
43718	David Dixon	Cabot Drug Store, Chicopee, Mass.	0.15

SPIRIT OF CAMPHOR

This preparation should contain not less than 9.5 gm. nor more than 10.5 gm. of camphor in each 100 cc. of solution.

Nine samples were analyzed and all were within the limits of the standard or reasonably close to those limits.

TABLE VII. ASSAY OF SPIRIT OF CAMPHOR

No.	Dealer	Manufacturer	Camphor, gms/100 cc.
	Cornwall Bridge		
42949	H. W. O'Dell	C. W. Whittlesey Co., New Haven	10.6
	East Berlin		
42910	Robert Cole	Sisson Drug Co., Hartford	11.0
	Moodus		
43708	Purple & Silliman	Sisson Drug Co., Hartford	10.5
	Old Mystic		
42941	W. S. Walbridge	Charles Osgood Co., Norwich	11.2
	Quinnebaug		
43713	Fred E. Willette	Charles Osgood Co., Norwich	10.3
	Rock Fall		
43725	Collins & Lindemark	Williams & Carlton Co., Hartford	8.9
	Southington		
43737	E. W. Ferguson	Apothecaries Hall Co., Waterbury	9.5
	Tariffville		
42905	B. F. Farrell	Foley & Co., Chicago	10.6
	West Goshen		
42946	H. H. Ives	Williams & Carlton Co., Hartford	10.4

SPIRIT OF ETHYL NITRITE

This preparation, also called sweet spirit of nitre, should contain not less than 3.5 nor more than 4.5 per cent of ethyl nitrite ($C_2H_5NO_2$).

An important consideration in keeping this product, and one that is emphasized in the United States Pharmacopoeia, is that it shall be kept in small, well stoppered, amber bottles in a cool, dark place, remote from fire.

The large proportion of substandard samples found in this and other inspections is no doubt due largely to failure to observe these precautions.

Thirteen samples were examined, of which six were passed.

TABLE VIII. ASSAY OF SPIRIT OF ETHYL NITRITE

No.	Dealer		Ethyl Nitrite, %
	Addison		
42931	Addison Cash Grocery	Hartford Drug Co., Hartford	3.0
	Cobalt		
43704	Ed. Elkin	Sisson Drug Co., Hartford	3.3
	Columbia		
42932	H. W. Porter	Charles Osgood Co., Norwich	2.3
	Cornwall Bridge		
42948	H. W. O'Dell	C. W. Whittlesey Co., New Haven	3.2
	Granby		
42906	H. L. Cowles	Williams & Carlton Co., Hartford	4.7
	Hartford		
43729	Sunlight Grocery	Sisson Drug Co., Hartford	4.2
	Quinnebaug		
43712	Fred E. Willette	Charles Osgood Co., Norwich	2.3
	Rock Fall		
43726	Collins & Lindemark	Williams & Carlton Co., Hartford	2.5
	South Coventry		
42937	*L. M. Phillips*	*Fraser Tablet Co., Inc., Brook*lyn N. Y.	3.9
	Southington		
43735	E. W. Ferguson	United Chemists, Jersey City, N. J.	0.4
	South Woodstock		
42921	R. K. Safford	S. Kidder & Co., Boston	3.0
	Thompsonville		
43715	David Dixon	Cabot Drug Co., Chicopee, Mass.	2.6
	West Goshen		
42944	H. H. Ives	Williams & Carlton Co., Hartford	3.4

TINCTURE OF IODINE

Tincture of iodine should contain not less than 6.5 gms. nor more than 7.5 gms. of iodine, and not less than 4.5 gms. nor more than 7.5 gms. of potassium iodide in each 100 cc. of solution.

Ten samples were examined, only one of which was notably deficient.

TABLE IX. ASSAY OF TINCTURE OF IODINE

No.	Dealer	Manufacturer	Iodine, gms/100 cc.	Potass. iodide, gms/100 cc
	Bloomfield			
42902	L. R. Ladd	American Lab., Inc., Richmond, Va.	5.8	4.9
	Collinsville			
42913	Philip Reichert	Dill Co., Morristown, Pa.,	6.4	4.6
	Columbia			
42933	H. W. Porter	Charles Osgood Co., Norwich	6.7	4.9
	Cornwall Bridge			
43700	H. W. O'Dell	C. W. Whittlesey Co., New Haven	6.7	4.7
	East Berlin			
42909	Robert Cole	Sisson Drug Co., Hartford	7.0	5.1
	Granby			
42908	Loomis Bros. Co.	Williams & Carlton Co., Hartford	7.0	5.0
	North Woodstock			
42920	O. Milligan	Lee & Osgood Co., Norwich	7.1	5.2
	Old Mystic			
42942	W. S. Walbridge	....	6.6	4.8
	Quinnebaug			
43714	Fred E. Willette	Charles Osgood Co., Norwich	6.7	4.9
	South Coventry			
42938	L. M. Phillips	United Drug Co.	6.8	5.0

SOLUTION OF MAGNESIUM CITRATE

This product should contain not less than 1.5 gms. of magnesium oxide (MgO), in each 100 cc. of solution. The specifications further require not less than 3.3 gms. of free citric acid and not less than 9.8 gms. of total citric acid in 100 cc.

Eight samples were submitted. Three were passed and five were below standard in one or more particulars. All were sold

upon request for solution of magnesium citrate or "citrate of magnesia." One, however, was labelled "Citro" with the further information that the article was a substitute for the U. S. P. product, and the formula was given. Another was labelled "Aperient" magnesia and two were labelled to show that they were made according to the specifications of the ninth revision of the Pharmacopoeia instead of the text now official.

"Citro" was deficient in total citric acid even on the basis of the declared formula, but in other respects conformed to the declaration.

Aperient magnesia was low in magnesia and in total citric acid for the U. S. P. article. The term "aperient" is as correctly applied to the standard U. S. P. product as to a substandard product so that such designation is not sufficiently descriptive to indicate to the consumer the substandard character of the article.

Sample 42925 was labelled U. S. P.: IX but it was low in total

TABLE X. ASSAY OF SOLUTION OF CITRATE OF MAGNESIA

No.	Dealer	Manufacturer Manufacturer	MgO, gms/100 cc.	Free citric acid, gms/100 cc.	Total citric acid, gms/100 cc.
	Beacon Falls				
42925	Peoples Grocery (U. S. P. IX)	Apothecaries Hall Co., Waterbury	1.6	2.5	8.3
	Berlin				
42912	J. Cole (Aperient)	Sisson Drug Co., Hartford	1.2	4.0	8.5
	Cornwall Bridge				
43701	H. W. Breen (Citro)	Williams & Carlton Co., Hartford	1.1	2.0	6.4
	Hamden				
43738	Robert Reinwald	Charles S. Leete Co., Inc., New Haven	1.6	2.4	8.4
43739	M. Tomassi	Superior Drug Co., Stamford	1.6	2.3	8.1
	North Stonington				
42940	Brown & Stone	Sterling Magnesia Co., New York	1.6	3.8	9.6
	South Woodstock				
42922	R. K. Safford	McCambridge Co., Washington, D. C.	1.5	3.9	9.3
	Tariffville				
42903	B. F. Farrell	National Magnesia Co., Brooklyn, N. Y.	1.6	3.8	9.5

citric acid on the basis of that standard. Sample 43739 was similarly labelled but it was deficient in free citric acid and in total citric acid.

There is apparently some difficulty in preparing this official solution to fully meet the standard for total citric acid although it can be made closely to approximate the standard. An experimental mixture made in the laboratory showed 9.65 grams total citric acid instead of the calculated value of 9.81 and a sample of freshly prepared stock, submitted at our request by a local druggist, was also slightly under the required value. However, with ingredients of U. S. P. purity there should be no difficulty in preparing a product that will pass inspection with a reasonable tolerance.

ESSENCE OF PEPPERMINT

According to the formula given in the U. S. P. this article should contain 10 per cent of peppermint oil per 100 cc.

Four samples were examined. Two were satisfactory, one was somewhat over strength and one was labelled "extract" but was below standard for that product. Extract should contain 3.0 per cent of oil.

TABLE XI. ASSAY OF ESSENCE OF PEPPERMINT, ETC.

No.	Dealer	Manufacturer	Oil of Peppermint %
	Moodus		
43707	Purple & Silliman	Sisson Drug Co., Hartford	11.9
	South Coventry		
42936	L. M. Phillips	Continental Drug Corp., St. Louis, Mo.	10.7
	Thompsonville		
43716	David Dixon	Eastern Drug Co., Boston	10.8
	West Goshen		
42945	H. H. Ives (Extract)	Williams & Carlton Co., Hartford	2.5

COMPOUND MIXTURE OF RHUBARB

From the formula for this preparation it is calculated that 100 cc. should contain from .004 to .005 gm. of ipecac alkaloids and 3.5 gms. of bicarbonate of soda.

The one sample examined contained 3.8 gms. of sodium bicarbonate and .014 gm. of mixed alkaloids. The alkaloidal residue was evidently contaminated and the value is no doubt too high. Tests for rhubarb were positive.

MISCELLANEOUS

DRUGS AND OTHER MATERIALS

The following materials, 21 in number, have been examined for the Dairy Food Commissioner, local health officers or other officials interested:

42985. *Alcohol.* Contained 3.8 per cent of methyl alcohol by volume. Total alcohols 43.25 per cent.

1148, 1149. *Apples.* These were examined for spray residue and 0.0016 and 0.0015 grains of arsenic (As_2O_3) per pound of fruit were found. These amounts are well within the limit at present allowed, viz., 0.01 grain per pound.

2718. *Coal* (Station sample). Water 1.10 per cent; ash 6.47 per cent; volatile combustible matter 20.2 per cent; fixed carbon 72.23 per cent; sulfur 0.94 per cent.

768. *Cod liver oil.* Free fatty acids as, oleic acid, 0.53 per cent; saponification No. 183.0; iodine No. 166.7; unsaponifiable 0.26 per cent; vitamin test, color value 26. Constants meet U. S. P. specifications. Color value indicated a probably satisfactory vitamin A content.

1359, 1360. *Cod liver oil.* For poultry feeding. There is no reliable way of comparing the two oils as to vitamin potency except by feeding trials. Color values for vitamin A indicated relatively large amounts of this factor, the respective values being 75 and 60.

2050. *Dr. De Pew's Prescription 10,010.* Sample submitted by a patient. Advertising literature emphasizes the benefits to be derived from the administration of gland tissue or extracts and it is implied that this "treatment" contains such substances. The tablets were found to consist of, or to contain, starch, calcium phosphate, strychnine in medicinal quantity, a trace of iodine and some nitrogenous material. Thyroid or a similar gland tissue may be present.

2428. *Doz-it.* A medicated stock salt, Farmers Medicated Stock Salt Co., Mifflinburg, Pa. It was found to consist of, or to contain, chiefly common salt with some charcoal, Epsom salt and iron sulfate. Advertising literature is objectionable because there is no known medicine that will prevent abortion; nor is it at all likely that this salt will prevent cholera as the circular implies.

3102. *F. L. P.* A pickling and curing compound for meats said to consist of salt and saltpetre. It was found to contain about 75 per cent of salt and 25 per cent of nitrate of soda. Both of these substances are permissible preservatives for meats. The term "saltpetre," however, applies to potassium nitrate rather than to sodium nitrate. The latter is known as Chili saltpetre.

748. *Hall's Muneac.* Hall Remedy Co., Tampa, Fla. The medicine was described as a wonderful remedy for rheumatism and diseases arising from uric acid in the system. It was a mixture of hydrochloric and nitric acids and contained some free chlorine. Acidity 2.51 normal. Dilute nitrohydrochloric acid (N.F. 5) would have a total acidity of about 2.8 normal.

2177. *Liquid soap.* Analysis: water 83.5 per cent; ash 2.88 per cent; free potassium hydroxide none; free potassium carbonate 0.24 per cent; fatty acids 8.95 per cent; soap (fatty acids + combined K_2O), 10.68 per cent; non-soap ash 0.10 per cent; undetermined 5.5 per cent. Evidently a potassium oleate soap.

975. *Normacol.* A laxative preparation. Sample consisted of, or contained, agar-agar and a vegetable cathartic, probably senna extract, coated with chocolate.

43524. B. Paul's Henna. Nature's Hair Restorer. Said to be a mixture of henna, herbs and other harmless ingredients. There were two separate

powders. One was a brownish-green substance, which was apparently the dye proper. The other was marked "developer." The brownish powder contained copper and iron in quantity, was acid to litmus, and contained tannic acid. Crystals of copper sulfate could be seen under the microscope. Paraphenylenediamine test negative. Coal tar color may be present. Wool was dyed brown and the color could be partially removed with ammonia and a redye made. The "developer" was alkaline to litmus and to phenolphthalein. No organic matter was present. Tests for sodium, peroxide and borate were positive. The preparation evidently owes its coloring properties to the reaction between the metals and tannic acid by which cupric and ferric tannate is formed. Some other dye (e. g. coal tar), may be present and possibly some henna, as there was organic material present other than tannic acid. Conjunctivitis was thought to have followed the use of this preparation. The high alkalinity of the developer might have caused such a condition.

3160-3166 incl. *Silver polishes.* Tested for cyanide. No evidence of cyanide was found in any of the samples. The test used was that of Schonbein-Pagenstecher (Anteureith and Warren, p. 21). The brands tested were Gelbard's "Just Rite," Green's, Whiting's, Wright's, Noxon, Priscilla, and Removit.

MATERIALS EXAMINED CHIEFLY FOR POISONS

Fifty-five other samples, chiefly instances of suspected poisoning of domestic animals, have been examined at the request of the Commissioner on Domestic Animals and of other officers having similar interests. Some examinations have been made for individuals. Detailed discussion of each of these is not required.

Examinations of this kind require very careful work and consume a considerable amount of time. However, this coöperation appears to serve a useful purpose and it is appreciated by the authorities concerned.

TOBACCO

In addition to partial analyses of 167 samples of tobacco, chiefly determinations of various ash constituents made in connection with tobacco investigations of the Station which are to be reported elsewhere, proximate analyses of tobacco seed and of fresh and cured leaves were made. The carbohydrate separations were made by Mr. Shepard.

PROXIMATE ANALYSIS OF TOBACCO SEED

Water	3.34%
Ash	3.71
Protein (N x 5.34)	20.76
Fiber	14.44
Carbohydrate (other than fiber):	
Starch	none
Water-sol. after hydrolysis, calc. as dextrose	3.08
Water-insol. after hydrolysis, calc. as dextrose	0.55
Undetermined	11.89
Fat, ether extract	42.23

The factor 5.34 for the evaluation of nitrogen in terms of protein is based upon the work of Vickery and Pucher.[1] Water-insoluble carbohydrates represent cell wall constituents converted to reducing sugars upon acid hydrolysis and calculated as dextrose.

PROXIMATE ANALYSES OF TOBACCO, CURED LEAF AND FRESH LEAF

(Air-dry-basis)

	2190 Air dry fermented leaf	4057 Air dry fresh leaf
Water	6.38%	4.50%
Ash	20.80	18.09
Nitrogen, total	4.46	4.51
Fiber	7.18	8.11
Carbohydrate other than fiber:		
Sol. in hot 95% alcohol calc. as dextrose	1.07	2.39
Sol. in water, calc. as dextrose	0.97	0.84
Starch	1.88	1.51
Hemicelluloses, calc. as dextrose	1.47	1.85
Fat (ether extract)	3.20	6.43

Nitrogen is not evaluated as protein because in the cured leaf of tobacco as much as 25 per cent of the total nitrogen may be present in the form of nitrate, about 10 per cent in alkaloidal combination and a smaller amount may be present in ammonium salts.

For the separation of the carbohydrates the fine-ground air-dry tobacco was extracted with petroleum ether and the ether-extracted material then boiled for eight hours with 95 per cent alcohol, enough sodium carbonate being added to neutralize the predetermined acidity of the tobacco. The extract was evaporated to remove alcohol and the residue dissolved as far as possible by repeated additions and decantations of hot water. There was some gum-like material, which did not dissolve. The soluble portion of the alcohol extract was made up to definite volume and aliquots were taken for the determination of reducing power. Sugars were calculated both from the weights of cuprous oxide and from copper determined therein volumetrically. Direct reduction sugar, calculated as dextrose, was found to be 1.02 per cent in the cured leaf and 2.40 per cent in the fresh leaf, both results being on the basis of the original air-dry tobacco. After a 10-minute inversion with hydrochloric acid the reducing power indicated little or no change in sugar, 1.07 per cent being found in the cured leaf and 2.39 per cent in the fresh leaf. A long hydrolysis (two and one-half hours), with dilute acid resulted in a decrease in sugar in both

[1] Dept. of Biochemistry, unpublished data.

cases, probably due to destruction of some carbohydrate. The identity of the sugars present was not established. Mosca[1] however, has reported the presence of levulose in tobacco examined by him, and Smirnow and his co-workers[2] have reported sucrose, maltose and monosaccharides. Our failure to obtain any considerable increase in reducing power after a short hydrolysis indicates no appreciable amount of sucrose in these samples. The behavior on longer hydrolysis is consistent with that which would be expected if levulose or invert sugar were present.

The ether and alcohol extracted material was next extracted with water to remove dextrins and any water-soluble hemicelluloses which might be present. The water extract was then hydrolyzed with 1.25 per cent hydrochloric acid for two and one-half hours and the copper reducing power of the hydrolyzed solution determined. Carbohydrate, expressed as dextrose, was found to be 0.97 and 0.84 per cent in the cured and the fresh leaves respectively, both results being on the basis of the original air-dry tobacco.

Another portion of the ether and alcohol extracted material was extracted with water and then digested with malt extract for the determination of starch. Starch was found to comprise 1.88 per cent of the air-dry cured leaf and 1.51 per cent of the air-dry fresh leaf.

The residue from the malt digestion was washed free from soluble carbohydrates and then hydrolyzed for two and one-half hours with dilute acid to convert hemicelluloses (cell wall constituents) into reducing sugars. Reducing sugars from this source accounted for 1.47 and 1.85 per cent of the air-dry cured leaf and the air-dry fresh leaf respectively.

Crude fat as reported in the analysis is the extract obtained by the use of ethyl ether after extraction for 16 hours.

POTATOES

In collaboration with the Storrs station, 22 samples of potatoes were analyzed. Eleven of these represented tubers after digging in the fall of 1928 and eleven represented the same varieties just before planting in the spring of 1929. Determinations of proximate constituent groups and certain of the ash constituents were made.

Discussion of this work is for publication elsewhere.

BEETS

Seventeen samples of beets were examined for sugar content, for the Department of Soils of this Station.

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[1] Zeitschr. f. Untersuchung Nahr. Genussm., 33: 93. 1917.
[2] Planta Archiv fur wissenschaftliche Botanik, 6: 687. 1928.

WATER

Under the provisions of a statute this laboratory collaborates with the State Water Commission in the investigation of waters polluted by trade wastes. Six samples have been examined during the year and the results reported to Mr. Copeland, sanitary engineer to the Commission.

BABCOCK AND OTHER GLASSWARE

During the year, 2,427 pieces of Babcock test bottles and pipettes and 111 dairy thermometers have been checked, making a total of 2,538 pieces.

	Accurate	Rejected	Total
Test bottles and pipettes	2415	12	2427
Thermometers	102	9	111

INDEX

Aromatic spirits of ammonia, 810; analyses of, 810
Babcock Glassware, etc., 821
Beets, 820
B. Paul's Henna, 817
Beverages, soda water type, 780
  Malt, near beer type, 780
Camphor, spirit of, 812
  analyses of, 812
Cereal products, etc.:
  Breakfast foods, etc., *780 analyses* of, 781
  Flour, bread, etc., 787; analyses of, 787
Coffee:
  Dacosta, analysis of, 787
  Al-Mo-Co, analysis of, 788
Dr. Depew's Prescription 10,010, 817
Doz-it, 817
Eggs, 788
Ethyl nitrite, spirit of, 813
  analyses of, 813
Fats and oils:
  Butter, 788
  Oleomargarine, 788
  Olive oil, etc., 789
Foods, special and miscellaneous, 789
  analyses of, 791
Fruit products:
  Cider, 794
  Grape fruit juice, 794
  Grape juice, etc., 794
Hall's Muneac, 817
Honey, 794
Ice cream, etc., 794; analyses of, 796
Iodine, tincture of, 814
  analyses of, 814
Jams and jellies, 794
Lime water, analyses of, 811
Magnesium citrate, solution of, 814
  analyses of, 815
Materials examined chiefly for poison, *818*
Meat products:
  Hamburg steak, 804
  Frankfurts, 805
  Pork sausage, 805
  Meat loaf seasoning, 805
Milk and milk products:
  Market milk, 805
  Chocolated skimmed milk, 806
  Buttermilk, semi-solid, 806
  Evaporated milk, 806
  Powdered whole milk, 806
  Cream, 806
Normacol, 817
Peppermint, essence of, 816
  analyses of, 816
Potatoes, 820
Rhubarb, compound mixture of, 816
Tobacco, 818
  analyses of, 818, 819
Vinegar, 808
Water, 821

Bulletin 320 September, 1930

THE SOILS OF CONNECTICUT

Progress Report of Investigations 1924-1930

M. F. MORGAN

Connecticut
Agricultural Experiment Station
New Haven

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CONTENTS

PART I A DESCRIPTIVE INVENTORY OF CONNECTICUT SOILS 831
Terms Used in Soil Descriptions 831
Causes Contributing to Differences in Soils 837
Connecticut Soils Compared with Other Regions 842
General Topographical Features 844
Chief Characteristics and Distribution of Important Soil Groups 846
A Key to the Soil Types of Connecticut 858

PART II SOIL AND LAND COVER STUDIES 870

PART III A CRITICAL STUDY OF CHEMICAL COMPOSITION OF REPRESENTATIVE CONNECTICUT SOILS 877
Organic Matter and Nitrogen 877
Total and Available Phosphorus 880
Total and Replaceable Potassium 883
Calcium and Magnesium 886
Acidity and Lime Requirement 887
Aluminum and Manganese 889

PART IV NUTRIENT REQUIREMENTS OF CONNECTICUT SOILS AS MEASURED BY GREENHOUSE AND SOIL FRAME EXPERIMENTS 891
Alfalfa 894
Buckwheat 897
Lettuce 897
Tobacco 900
Chemical composition as related to soil treatments 905
Oats 906
Sweet Peppers 907
Carrots 908
Other Crops 908

GENERAL SUMMARY 909

FOREWORD

The Soils Department of this Station was organized in July, 1923. During the first two years the work was confined largely to detailed soil surveys of selected areas of the state in coöperation with the Economics Department of the Storrs Agricultural Experiment Station in order to ascertain the distribution of the various soil types and their importance in determining the distribution of land cover and the type of agriculture. The work was expanded in 1925 under funds made available by the Purnell Act. Outstanding results of our studies have been reported from time to time in journal papers, press reports, talks at conferences and farmers' meetings, and in the annual reports of this Station. It now appears desirable to present the information which has been accumulating as a bulletin of comprehensive nature.

The results of a considerable amount of soil studies with special reference to forestry problems are not included, since this material is part of a separate bulletin which is being prepared for publication.

The first soil survey by the United States Bureau of Soils was made in the Connecticut Valley in 1899. This was enlarged to include a considerable adjacent area in 1902. A decade later, in 1911 and 1912, the counties of Windham and New London were also covered. However, all of this early work was of a rather general character, many very important soil differences were not recognized, and the location of soil areas on the map was frequently inaccurate. In spite of these limitations, these older surveys have served a useful purpose, especially in the Hartford County area, where the physical characteristics of the soils most desirable for cigar-wrapper tobacco were clearly shown.

Since the discontinuance of their soil survey work in this state, the United States Bureau of Soils (now the Bureau of Chemistry and Soils) has greatly improved its system of classification and the accuracy of the maps, which now cover nearly one-half of the farm land of the United States.

The work is usually done in close coöperation with the soils departments of the state experiment stations and the published reports present detailed soil maps and descriptions of each soil with respect to their natural character and relationships to crops, fertilizer practices and farm values. These reports furnish invaluable information, not only to the individual farmer, but to the extension worker who offers him advice, the research man who studies his problems, the organizations that direct his collective efforts and the banker who loans him money on the value of his land. They are necessary in activities involving policies of land

utilization such as forestry, recreation and wild life. They furnish a physical basis for estimates of road construction problems. In fact, a knowledge of the natural soil factors as pictured by the soil survey is of prime importance in any program relating to an intelligent direction of the future development of all non-industrial activities of the state.

Connecticut, while extremely varied in the minor details of the character of its soils, presents a very simple problem to the trained soil surveyor, on account of its small size and excellent transportation facilities. However, the present topographic map, prepared over forty years ago and relatively inaccurate in detail, is not a satisfactory basis for the accurate location of the various small areas of soil types that occur on nearly every farm. A new topographic map of the state, prepared with the assistance of data obtained from aerial photographs, and printed on a scale of at least one inch to a half mile, would be necessary, but since such a map is seriously needed to meet many other demands of the state, it will doubtless be prepared within the near future.

The material presented in this bulletin, supplemented by other information which will be accumulated in the course of our future investigations, should furnish an excellent basis for the intelligent interpretation of the soil survey when it is prepared. The ground work has been done, which includes the development of an adequate basis of classification and maps already prepared for the equivalent of 20 different towns. It is earnestly hoped that as quickly as a new aeroplane photograph or topographic survey of the state is available, the detailed application of our knowledge of the soil factors in agriculture, forestry and related fields may be made possible through a state-wide soil survey.

The author is indebted to the following persons for their contributions and coöperation in connection with various phases of the subject matter presented in this bulletin:

G. D. Scarseth, former Assistant in Soils Research, and H. G. M. Jacobson, Assistant Agronomist, for soil and land cover maps, laboratory analyses and greenhouse studies.

D. B. Downs, General Assistant, for land cover maps and greenhouse studies.

Mark Baldwin, Inspector, Soil Survey Division, United States Bureau of Chemistry and Soils; G. W. Conrey, Chief of Soil Survey, Ohio Agricultural Experiment Station, and W. H. Latimer, Soil Surveyor, United States Bureau of Chemistry and Soils for soil type identifications and correlations.

I. G. Davis and C. I. Hendrickson, Economics Department, Storrs Agricultural Experiment Station, for economic studies on various soil types.

M. F. M.

PART I

A DESCRIPTIVE INVENTORY OF CONNECTICUT SOILS

Connecticut is a state of diversified agriculture, and the economic trend is in the direction of increased diversification and more intensive use of land wherever possible. The soils of the region are extremely varied in their characteristics, and it is believed that a better understanding of these soil differences and their significance will be of material assistance in improving the adjustment of land utilization to soil.

The specific purpose of this portion of the bulletin is to furnish a "guide-book," whereby the various types of soil can be systematically studied, and to present certain data that indicate the agronomic significance of some of the more important soil differences to be observed.

A detailed soil map of the state cannot be available for a number of years. It is our hope that the material herein presented will enable the reader to recognize the more important soil types and to understand something of their relationships to agricultural use.

Terms Used in Soil Descriptions

It is not possible to describe adequately soil conditions without using a number of terms somewhat unfamiliar to many readers. The following paragraphs are necessary to make the meanings of such expressions more understandable.

Surface soil. The upper portion of a soil in which the mineral soil is mixed with a certain amount of organic matter, and is thus darker in color than the lower layers of soil.

Subsoil. The soil layer underlying the surface soil, and extending to a depth where there is a noticeable difference in character of the material.

Substratum. The material underlying the subsoil, and usually extending practically unchanged to bedrock formations.

Soil horizon. In a scientific study of soils as they occur in the field, the various layers of the soil are designated as "horizons." These horizons are more or less distinct, and are of great significance in showing the conditions under which the soil is developed.

In the regions of the world where the downward movement of water in the soil is practically continuous, such as is the case in all the eastern half of the United States, the soils tend to form

two important horizons. The "A" horizon, the one nearest the surface and immediately below the leaf mold, if such exists, is a zone from which soluble material and the very finest soil particles designated as "colloids" tend to move downward. In all cultivated soils and in some virgin soils, at least the upper portion and sometimes all of this horizon contains enough organic matter to be darker than the lower layers of the soil. Thus there may be both "A_1" and "A_2" horizons, the former containing more organic matter, but both being "A" horizons in the sense described above.

The "B" horizon, occupying a position just beneath the "A" horizon, shows evidence that at least some of the material that has moved down from the "A" horizon has tended to accumulate in this zone. There may be differences in this general horizon, such as in color and clay content, to justify separation into B_1, B_2, etc., horizons.

Below the "B" horizon lies the rock material from which the soil is formed. In Connecticut, except where solid bedrock lies within two or three feet of the surface, this material is usually a mixture of loose stones or gravel, sand, silt and clay in varying proportions, laid down as glacial deposits or as sediments from running water. Such material is designated as the "C" horizon, although not soil in the strictest sense.

Soil color. Soils show many variations in color, and these are frequently valuable aids in distinguishing between different soils. Thirty-one standard soil color names have been selected for use in describing different color variations to be recognized in this state. In order that scientific workers in other states may properly interpret these names, these colors have been analyzed by means of the Munsell color disc method. The results are as follows:

TABLE I. ANALYSIS OF CONNECTICUT SOIL COLORS.

	White (Neutral 9)	Yellow (Yellow 8/8)	Red (Red 4/9)	Black (Neutral 1)
Light gray	45	4	0	51
Gray	36	13	0	51
Cream	34	36	0	28
Yellowish-gray	16	35	0	49
Yellow	4	30	8	58
Grayish yellow-brown	14	23	0	63
Yellowish-brown	6	26	8	60
Yellowish-brown with slight reddish cast	6	21	11	62
Medium brown	11	16	2	71
Medium brown with slight yellowish cast	7	23	4	66
Medium brown with slight reddish cast	9	15	10	66
Dark brown	6	15	2	77
Light grayish-brown	19	20	0	61
Grayish-brown	12	13	0	75

	White (Neutral 9)	Yellow (Yellow 8/8)	Red (Red 4/9)	Black (Neutral 1)
Dark grayish-brown	10	10	0	80
Very dark grayish-brown	9	6	0	85
Black	9	1	0	90
Reddish-gray	32	21	15	32
Reddish-yellow	11	21	19	49
Light reddish-brown	14	17	15	54
Reddish-brown	14	15	13	58
Dark reddish-brown	10	11	9	70
Brownish-red	13	13	21	53
Olive-gray	28	11	0	61
Dark olive-gray	20	9	0	71
Bluish-olive	20	7	0	73
Yellowish-olive	22	18	0	70
Olive-drab	20	15	0	65
Drab	26	17	0	57
Dark olive-drab	16	11	0	72

Soil texture. The texture is determined by the sizes of the soil grains which compose the soil. From this standpoint, the coarse material, larger in diameter than two millimeters (about 0.08 inch), is not included in the calculation. The names applied to the various sizes of soil particles as used by the United States Bureau of Soils are as follows:

TABLE II. THE NAMES AND RANGES IN SIZE OF SOIL PARTICLES.

Separate	Diameter in mms.
Very coarse sand	2.0 — 1.0
Coarse sand	1.0 — 0.5
Medium sand	0.5 — 0.25
Fine sand	0.25 — 0.10
Very fine sand	0.10 — 0.05
Total sands	2.0 — 0.05
Silt	0.05 — 0.005
Clay	0.005 and smaller size

Soils contain varying proportions of particles of all the different sizes. Few soils contain more than 90 per cent of total sands, while even the heaviest clays seldom exceed 60 per cent clay.

For convenience in designating soils with different relative proportions of sand silt and clay, textural class names are used. The following classes occur in this state in areas of appreciable size:

Coarse sand—
Less than 15 per cent silt and clay.
35 per cent or more coarse and very coarse sand.

Sand—
Less than 15 per cent silt and clay.
35 per cent or more very coarse and coarse sand.

Loamy sand—
15 to 20 per cent silt and clay.
35 per cent or more very coarse, coarse and medium sand.

Loamy fine sand—
15 to 20 per cent silt and clay.
35 per cent or more very fine and fine sand.

Sandy loam—
20 to 50 per cent silt and clay.
25 per cent or more very coarse, coarse and medium sand.

Fine sandy loam—
20 to 50 per cent silt and clay.
25 per cent or more very coarse, coarse and medium sand.

Very fine sandy loam—
20 to 50 per cent silt and clay.
35 per cent or more very fine sand.

Loam—
Less than 20 per cent clay.
30 to 50 per cent silt.
30 to 50 per cent sand.

Silt loam—
Less than 20 per cent clay.
More than 50 per cent silt.
Less than 50 per cent sand.

Clay loam—
20 to 30 per cent clay.

Clay—
30 per cent or more clay.

Soil colloids. The extremely fine particles in the soil are called colloids. Due to their large surface in proportion to their weight, they exhibit many important properties not possessed by larger soil grains. They are able to absorb not only moisture but also many important chemical components, such as potassium, calcium, ammonium and phosphate, although apparently able to liberate them to the plant under many conditions. The colloids also act as a cement between the larger particles, and may form a complete coating over the sand and silt grains. They thus cause them to cluster or granulate, and when large in amount may cause the soil to be very sticky when wet, thus making the soils difficult to work. The poor condition produced by an excessive amount of colloids may be partially corrected by organic matter and lime. Soils low in colloids are not retentive of moisture and plant food material, and are lacking in "body." A moderate amount of colloids in proportion to the amount of sand and silt is most desirable.

Organic matter and humus. Plant and animal material enter the soil from the following sources: leaves, bark, twigs and other forest debris; dead grass, roots, stems and other crop residues; the bodies of earth worms and insects; the dead cells of bacteria, fungi and other micro-organisms; applications of animal manures, straw, tobacco stems and stalks, and fertilizers of organic substances such as cottonseed meal, castor pomace or fish scraps. This material in the soil is attacked by bacteria and fungi thus

gradually decomposing into more or less stable organic compounds of complex nature. All organic substances, in any stage of decomposition, are included in the general term "organic matter," as applied to soils. The well decomposed material, which has lost its original physical and chemical form, is usually called "humus." In a cultivated soil the greater portion of the organic matter is in a humus condition, and is mixed with more or less mineral soil. Well-drained soils contain from 1 to 10 per cent of organic matter in the surface layer, while swamp accumulations, known as peat, may be almost pure organic matter.

Organic matter in soils performs many important functions. It makes a heavy clay soil more easy to till, and increases the retentiveness of a very sandy soil for moisture. It increases the ability of a soil to absorb heat. Aside from these physical effects, organic matter is the food and energy supply for bacteria and fungi and through their activities plant food contained in the organic matter is made available for crop growth. The carbon dioxide set free in the decay of the organic matter greatly increases the solvent action of the soil water on the mineral matter in the soil, thus increasing its availability.

Nitrogen. Closely related to organic matter is the nitrogen supply in the soil. In fact the total amount of nitrogen in the soil is usually about five per cent of the amount of organic matter. Only a small portion of this nitrogen is available for plant growth at any one time. It is released from the decomposing organic matter by the action of bacteria and fungi, and a small amount of nitrogen is taken directly from the air and added to the soil through the action of two important groups of bacteria, one of which produces the nodules on the roots of leguminous plants, while the other is able to fix nitrogen from the air without the assistance of a host plant, when soil conditions are favorable.

Chemical elements essential to plant growth. Carbon and oxygen are obtained by the plant from the atmosphere. Hydrogen and oxygen are furnished by the water entering the plant roots through the soil. The soil also furnishes the plant with the following essential elements: Nitrogen, Potassium, Phosphorus, Sulfur, Magnesium, Calcium, Iron, Manganese, and perhaps others such as Boron, Copper and Zinc, minute quantities of which may play some important part in the life processes of the plant. Silicon and aluminum are absorbed by the plant from the soil in considerable amounts, but it has not been definitely proven that they are required by the plant.

All soils contain these elements. An average soil in Connecticut shows a total amount of all the more important elements sufficient for hundreds of years of cropping. But most of the supply is combined in the soil minerals and slowly decomposing organic

matter in such a way as to permit only small fractions to be available to the plant in the season of its growth.

Three of these elements, Nitrogen, Phosphorus and Potassium, are so often available in insufficient quantities for many crops that they are added in the form of animal manures or fertilizers. The soil may under certain conditions be deficient in calcium, magnesium, sulfur or manganese. The other "essential" elements are almost always furnished to the plant by the soil in adequate amounts.

Soil reaction. Water that is in contact with the soil particles is affected by them, and is either made acid or alkaline or may remain neutral. This property of the soil is called soil reaction. It is one of the most important of soil characteristics, since the degree of acidity or alkalinity is related to a great many other soil processes, such as the liberation of injurious inorganic compounds in the soil, the decomposition of organic matter, the formation of nitrates, fixation of nitrogen from the air, and solubility of nutrient elements such as phosphorus and calcium.

The strength or intensity of soil reaction is now almost universally measured in terms of a scale of figures, known as "pH," in which 7 pH expresses approximate neutrality (neither acid nor alkaline). Six, 5 or 4 pH indicate increasing degrees of acidity, while 8, 9 or 10 pH represent increasing degrees of alkalinity.

Lime requirement. The intensity of soil acidity does not show the total amount of acidity, or vice versa, the amount of lime which must be applied to neutralize completely this acidity. The total acidity depends not only upon its strength, but upon other factors, chief of which are the amounts of organic matter and clay in the soil.

The "lime requirement" of the soil is not usually the same as the lime requirement of the crop, since plants vary greatly in their ability to withstand acid conditions, and many crops are most satisfactory on soils with moderate lime requirement and a slight intensity of acidity. Hence laboratory measurements of lime requirement must be interpreted in the light of the preferences of the crop to be grown.

Common rocks that contribute material for soil formations in Connecticut:

Granite. A grayish-colored, hard, massive rock containing recognizable crystals of quartz, feldspar and mica, as well as other accessory minerals.

Syenite. Light gray or pinkish-gray, hard, massive, composed chiefly of feldspar with smaller amounts of mica and little or no quartz.

Diorite. Dark gray or very dark gray, hard, massive, heavy for its bulk, composed of feldspar, black mica (biotite), and hornblende with little or no quartz.

Gneiss. A grayish-colored, hard, massive crystalline rock, showing evidences of having been changed through former intense heat and pressure

(metamorphism). Shows distinct banded arrangement of the crystals, the bands frequently being highly distorted. Gneiss may be a granite-gneiss, syenite-gneiss or diorite-gneiss, similar in mineral composition to these respective rocks.

Schist. Differs from gneiss in having closely paralleled layers, along which the rock tends to split. Flakes of some of the minerals, such as mica, chlorite or hornblende, are arranged in thin layers or "folia." Schists are designated by the mineral responsible for their foliation as mica-schist, chlorite-schist or hornblende-schist.

Trap. A dark gray, dark brown or nearly black, very hard and flinty rock occurring in characteristic columnar cliffs in many parts of the central region of Connecticut, such as West Peak in Meriden and East Rock, New Haven.

Phyllite. A dark-colored, slaty type of rock, with no noticeable mineral formation, but possessed of a glossy lustre due to minute flakes of mica. It breaks readily into thin plates.

Sandstone. A rock formed from the cementation and solidification of strata of sand and fine gravel, deposited at some remote geologic age. The most common examples in Connecticut are the reddish-colored sandstones of the Connecticut Valley formed in the Triassic Age.

Shale. Also a sedimentary rock, formed in the same fashion as sandstone but of very fine silt and clay material. The rock is thus fine-grained, splitting into thin plates, and has a dull lustre.

Limestone. A sedimentary rock, formed from the deposition of limy substance on the bottom of prehistoric lakes, bays or ocean floor, and later cemented by the carbonate of lime into a rock. The distinctive feature of limestone is the fact that it effervesces freely when hydrochloric acid comes into contact with it. Limestone that becomes crystalline due to metamorphic action is called *marble*.

Causes Contributing to Differences in Soil Occurring in Connecticut

The Character of the Rocks

The geologic past of southern New England has been such as to give us a wide variety of rocks, and the difference in their character has in many cases brought about a marked effect on the soil from which these rocks have been derived.

The greater portion of Connecticut, with the exception of the central portion and included in Areas I and II in Figure 59, represents a complex assortment of crystalline rocks varying from massive gray and pinkish granites and granite gneisses through a wide variation of composition, color and structure to fissile schists which sometimes approach the character of sandstones and which they may have been ages ago, before some titanic disturbance of the earth's crust destroyed the fossil evidences of the true origin of the rocks.

Near the northwestern corner of the state, in a narrow strip along the Upper Housatonic Valley and in the vicinity of Danbury (Area III in Figure 59), marble or limestone rock (the Stockbridge limestone) is found, a relic of submarine calcareous deposits laid down in a far distant past when the highest form of life was

the trilobite, a very strange cousin of the crabs and lobsters that now frequent our shores. With the exception of a very few small and scattered localities in Area IV where thin seams of limestone are found, particularly near Northford, no other calcareous rocks are found in the state. The absence of limestone rock over most of the state has contributed largely to the acidity that is characteristic of most of our soils.

Central Connecticut, and a small area in the Pomperaug Valley (Area IV), have had an entirely different history. At a period millions of years later than when the Stockbridge limestone was formed, and when evolution had proceeded as high as the gigantic reptile forms of the Triassic Age, certain changes in the earth's surface brought this region under water and deposition of sandstone material on the bottom of this body of water began to take place. Climatic conditions and the chemical nature of the water was such as to give a reddish color to the cementing material that developed about these sand grains. The latter were usually composed of small and but slightly weathered fragments of the crystalline rocks of the rugged uplands of eastern and western Connecticut, from which they were washed by torrential streams.

During the same period great sheets of molten rock welled up from far below the surface and either spread out over the surface, with additional deposits of sandstone laid down above it later, or forced itself horizontally from a central fissure between the strata of rock already formed. This lava cooled to form a dark-colored, firm-textured, minutely crystalline rock commonly known as "trap." Great "faults" occurred in the earth's surface, so that the truncated edges of these formations are now exposed as nearly perpendicnlar cliffs, almost invariably facing in a westerly direction in this state. The chief areas of rock of this type are shown in black in Figure 59.

The Effect of Glaciation

At a period estimated as between 15,000 and 30,000 years ago, the great ice age was in progress. The effects brought about by the advance and retreat of that great sheet of ice must be realized if we are to understand many important differences to be found in the soils described in this bulletin.

That great mass, thick enough to drown the summit of Mount Washington in its icy depths, flowed like so much molasses, yet infinitely slower, down across the northern part of our continent until a climate was reached sufficiently warm to melt it back as fast or faster than it oozed gradually southward. The farthest extent of the glacier in our section of the country was just south of Long Island. Thus the entire area of Connecticut was covered with ice.

In its advance, the glacier scraped over and scooped out the original soil that had probably covered the surface previously, and mixed it with rocks and rock fragments which it dug or snatched from the jagged edges of the irregular slopes. Much of this material was deposited as a thin mantle of "till" from several inches to a few feet in depth, overlying the fresh and unweathered surface of the resistant rock masses beneath. Occasionally the loose material being dragged along under the ice accumulated to considerable thickness, and piled up to such an extent that the ice

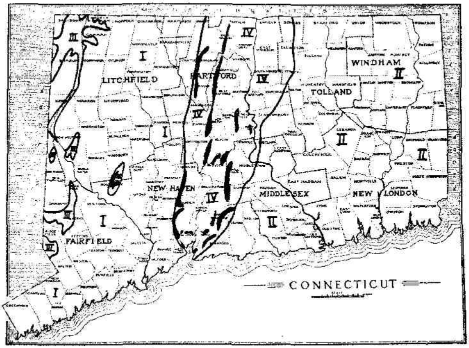

FIGURE 59. Chief physiographic and geologic regions of Connecticut. I. Western Highland of schists and gneiss rocks; II. Eastern Highland of gneiss and schist rocks; III. Western Valleys of limestone rock; IV. Central Lowland of triassic sandstone and shale rocks; black areas—"trap rock" ridges within Central Lowland.

rode over and around it, leaving long, narrow and smoothly convex ridges of material, usually a mile or so in length and about a quarter of a mile wide, rising to a height of from 75 to 200 feet above the surrounding surface. These ridges are called "drumlins." Many occur in the state, particularly in the western portion, as in the towns of Goshen, Litchfield and Bethlehem, and in northeastern Connecticut with best development in Woodstock and Pomfret.

In most cases the greater portion of the material thus spread upon the surface has been derived from rock formations either directly underlying or occurring within a mile or so to the north-

ward. Frequently the influence of a single small outcrop of a peculiarly colored rock can be clearly traced.

The ice sheet at its southermost limit deposited ridges of loose, coarse material highly mixed with boulders, called "terminal moraines." These are not found in Connecticut but at intervals in the melting of the glacier the ice front may have remained nearly stationary for certain periods of time. Thus there were deposited locally, deep and irregular deposits of coarse and comparatively loose morainic material.

As the ice melted, its surface was gradually lowered until the higher hills emerged, and the water released through melting, raced wildly down the temporary valleys thus formed between the edge of the glacier and the hill, frequently piling up irregular hummocks and short ridges of sand and coarse gravel. These deposits are called "kames." In such cases the water from the melting ice flowed for some distance under the glacier, dropping sand and coarse gravel along its more or less serpentine channel. When the ice had all disappeared, the former course of the sub-glacial-stream was left as a long and narrow and winding low ridge, usually rising 20 or 30 feet above the relatively level ground of the present valley floor. These formations are called "eskers." Kames and eskers are frequently found along the valleys of most small streams of the state, particularly those that flow toward the south.

With further melting of the ice, the broader valleys emerged, the lower portions of which were occupied by ice remnants and glacial debris. Extensive, nearly level plains of sandy material were built up by the swollen streams which flowed over these areas. When the ice melted so as to permit an outlet for the water at a lesser elevation, such a plain appeared as a terrace above the general level of the new stream flow. In many cases a series of successively lower terraces were thus formed until the entire valley was cleared of ice. This is the most logical explanation for the extensive areas of sandy soils, containing no boulders or large stones, which occur in the Connecticut Valley north of Middletown, and in smaller belts elsewhere along most of the larger streams of the state.

In some cases, the valley was dammed by the ice-deposited material after the glacier had melted from most of the low-lying lands in the immediate vicinity. In the quiet waters of the lake thus formed the fine silt and clay being washed into it from the melting glacier to the north was gradually deposited. In the summer coarser silt and very fine sand settled out on the bottom of the lake. In the winter, little additional coarser material was supplied because of decreased melting of glacial ice. The fine clay particles which require a long time to settle were then deposited. Thus the clay formations of these glacial lake bottoms show a

"laminated" effect of alternate layers of clay and silt, which record the procession of years during that period. Such clay deposits occur in the Connecticut Valley north of Rocky Hill and in the Mattabesset and Quinnipiac valleys.

When all the ice had melted from the headwaters of our streams, they subsided to their present size. Since then, their occasional floods have deposited some alluvial material on the areas commonly known as "bottomland," especially along the Connecticut River, where the width of such deposits sometimes exceeds half a mile. This recent alluvial material forms soils which are still being periodically changed by new flood deposits. Much fresh sand and silt was added to the Connecticut bottomlands in the great flood of 1927.

Climate

Given sufficient time, the effects of climate on soil formation are such as to completely blot out the differences in kind of rock from which the soils were originally formed. Thus in regions where the soil has been undisturbed for vast periods of time, and where very little erosion and consequent exposure of fresh material from below has taken place, as in many areas in the southern and western parts of the United States, the soil is practically the same, whether originally derived from granite, sandstone or limestone.

Different combinations of rainfall and temperature have thus produced major differences in soils in various parts of the world. In southern New England, regardless of the type of rock or the mode of deposition of the material, all the soils possess certain points of similarity which are distinct from the soils of northern New England, the South, the Middle West, the Great Plains and the arid regions of the Southwest. The soils of Connecticut lie at the border of a Climatic Soil Region and show gradations from the general soil characteristics of the soils of the Middle Atlantic States and the soils of northern New England and Southeastern Canada.

Since the soils of Connecticut are derived from material deposited on the surface by glacial action in geologically very recent time, and the rock material is for the most part rather resistant to the soil-forming processes brought about by our particular type of climate, the climatic effects are not as pronounced as might be otherwise expected.

Drainage

Differences in the rapidity with which percolating waters pass down through the soil, due to the presence or absence of heavier or more clayey substratum, have caused the soils to show corresponding variations in their weathered horizons. A periodical or

permanent waterlogging of the soil reveals evidences of this condition in the soil itself, such as mottled coloration of the subsoil (streaked with rusty, reddish yellow and gray), and the accumulation of more organic matter in the surface soil.

Erosion

Soils on exposed or very steep slopes have been modified by the washing away of the accumulations of organic matter on the surface and the removal of clay, silt and fine sand, leaving the soil depleted in organic matter or excessively stony, gravelly or sandy. While the region was forested, erosion had little effect except on very steep slopes, but since the land was cleared, the soil is frequently much affected.

Clearing and Cultivation

Immediately after the soil is cleared, rapid decomposition of the organic accumulations of the original forest floor begins to take place. This process is often hastened by burning, and goes on more rapidly when the soil is put under the plow, exposing a greater surface to the air and quickening the activities of the micro-organisms of the soil. Erosion is often permitted to take place. Crops are removed. Manure, fertilizer, or lime is added to the soil. The different soil horizons that occur within a few inches of the surface are mixed together. A soil that has once been cultivated or even only cleared and pastured for a few years, is a recognizably different soil for at least a century after it has reverted to woodland, from adjacent areas which have always been in forest.

Connecticut Soils as Compared with other Soils of the United States

As has already been mentioned, climate is the most important determining factor in the broad differences in soil which occur in different regions.

To the north of us, beginning to be fully developed in the higher areas of Litchfield County, lies a region of soils developed under conditions of long cold winters, heavy snowfall, and short, mild summers with abundant rainfall. The soils in their virgin state show a strikingly characteristic profile. (See Figure 60.) Beneath about three or four inches of dark brown, slowly decomposing forest humus there are about two or three inches of a peculiar light gray sandy material (A horizon). Directly under, this lie about two inches of dark coffee-brown, firm and compact mineral soil, becoming reddish-yellow-brown and more sandy in the several inches immediately below it (B horizon). The soils of this region possessing the gray layer directly under the leaf

mold, are called "podzol" soils by soil scientists and are classed by the United States Bureau of Soils as the "Canadian Family" of soils.

Southern New England and the region south to Washington, D. C., and westward to the prairies, have soils developed under the action of more moderate winters and warmer summers, with abundant rainfall well distributed through the year. The typical virgin soil (see Figure 60) has a thin, well decomposed layer of

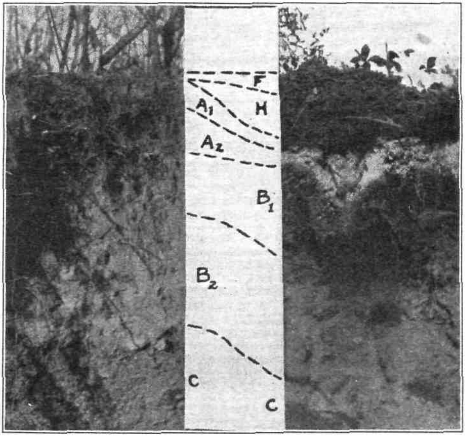

FIGURE 60. Typical non-podsolized or brown forest soil profile of Connecticut (left) and well podsolized forest soil profile of White Mountain region in New Hampshire.

leaf mold resting upon five or six inches of brown mellow loam. Under this the subsoil (B horizon) is somewhat heavier in texture, yellow brown to reddish-yellow brown in color and extending to the depth of 24 to 36 inches from the surface. Below this the substratum (C horizon) is usually of a grayish or grayish-brown color and coarser in texture than the subsoil.

Most Connecticut soils belong in this general group, which is termed the region of "brown forest soils" and classed under the "Jerseyan Family" by the United States Bureau of Soils.

However, there is an evident gradation toward the "Podzol Soil" character in many areas, particularly in northern Litchfield County. Besides this, the resistant character of the rock material and the relatively short time since glaciation have given the soils of Connecticut a somewhat different character than is typical of the climatic soil group.

In the South we have red and yellow soils, in the eastern prairies black soils without lime hardpan, in the western prairies black soils with lime hardpan, in the great plains "chestnut-colored" soils, and in the arid regions the desert gray and brown soils. All these soils are strikingly different from any of the soils of Connecticut, but their characteristics need not be described here.

General Description of the Topographic Features of the State

Connecticut is usually divided into three distinct physiographic regions. A central belt, extending north and south, about 20 miles wide at the Massachusetts border, and narrowing to five miles at New Haven, is known as the "Central Lowland." That part of the state west of this belt is called the Western Highland, while the area east of it is designated the Eastern Highland. In northwestern Litchfield County and in the vicinities of Danbury and New Milford an area should also be recognized which might be called the "Limestone Valleys."

The Central Lowland is characterized by a general low elevation, ranging from an average of about 50 feet at New Haven to about 200 feet at the Massachusetts border. Narrow belts of pronounced trap-rock ridges, extending in a general north-south direction, with sharp cliffs on their western faces and gentler slopes toward the east, rise to heights of from two to 400 feet above the adjacent lowland.

There are three general areas in the Central Lowland where extensive stretches of level or nearly level plains are to be found. The largest of these is in the Connecticut River Valley north and east of Hartford, in the Farmington Valley between Plainville and Southwick, Mass., and in the Quinnipiac Valley between New Haven and Meriden. Elsewhere the country is rolling to moderately hilly.

The Western Highland rises abruptly from the western edge of the Central Lowland to about 200 feet just west of New Haven and about 800 feet at the Massachusetts line. Toward the northwest there is a general rise to more than 2,000 feet at the northwestern corner of the state.

There is a considerable local range in elevation, and the greater portion of the region is hilly to mountainous in relief. Exceptions

to this are extensive areas where the uplands flatten out into long ridges with smooth outline and more gentle slopes. These ridges are of a uniform character, with their longer axes about three-quarters to one and one-half miles long and from one-quarter to three quarters of a mile wide. These have been previously described as drumlins. The most extensive development of this type of topography is in central Litchfield County.

The Limestone Valleys, lying within the Western Highland region, are from 200 to 1,000 feet lower in elevation. This is due to the more easily weathered type of rock. The topography is rolling to moderately hilly, in sharp contrast to the adjacent mountainous slopes.

The Eastern Highland rises abruptly from the eastern edge of the Central Lowland. The elevations are in general somewhat lower than in the Western Highland, ranging up to about 1,200 feet. Mountainous topography is only local in occurrence, and for the most part the surface is hilly, with a marked irregularity of relief. Since the hills are smaller than in northwestern Connecticut, there are many more of them in a given area than in northwestern Connecticut.

The drumlin type of topography occurs to a more limited extent in the Eastern Highland. Hills of this sort are numerous only in the vicinity of Woodstock, Pomfret and Lebanon. Isolated drumlins may be found elsewhere, but they make up a small proportion of the total area.

In the Eastern Highland region many of the valleys are partially or completely occupied by gravelly mound-like knolls of the "kame" type, with occasional narrow serpentine elevations called "eskers." The best development of such topography is in the Natchaug and Quinnebaug valleys. It occurs in the Western Highland in local areas only.

In both the Eastern and Western Highlands the larger streams may have level, sandy terraces at intervals along their courses. Flood plains are narrow and of small importance along the smaller streams of the highlands, and the only flood plains of any considerable size are those along the Connecticut River, in the portion of its course that lies in the Central Lowland.

Small inland swamps and bogs of from 10 to 500 acres in size occur in almost every town. Their total area amounts to about three per cent of the state.

Along the shore of Long Island Sound many tidal marshes are developed. As fingers these may extend two or more miles inland, and they are sometimes 1,000 or more acres in size. Frequently the tidal swamp is separated from the sea by narrow belts of sand thrown up by the waves and blown inland by the wind. The area of such formations is insignificant, being occupied almost entirely by shore cottages.

Chief Characteristics and Geographical Distribution of th Important Soils of Connecticut

In order to obtain accurate information as to nature of local soi differences, and to study the distribution of crops, pastures an forest on the various soils, careful field surveys have been con ducted on areas in the state represented in Figure 61. Map were prepared on the scale that one inch equals one-half mile which permitted the correct representation of all areas of soi larger than about two acres. However, since many fields contai "spots" of noticeably different soil that are only a few square rod in extent, absolute accuracy in soil mapping in a region of suc great local diversity could never be attained without exorbitan cost in the preparation and publication of maps of a scale of suc size.

Until financial provisions have been made for the complete sur vey of the state in reasonably accurate detail, the maps of the area already covered will be kept on file for the reference of intereste persons, but their publication will not be attempted.

However, from the information obtained in the course of thes surveys, supplemented by extensive reconnaissance over the entir state and by thorough study of existing maps showing the topog raphy, geology and forests, we have prepared an Outline Soi Map, which accompanies this bulletin.

This map is in no sense an attempt to show the exact local varia tion in soils. It is designed to represent the major areas of th main soil types of the state. The state is divided into areas desig nated as soil groups which are named from the characteristic soi that may be found within the area represented on the map. Man other soil types besides those thus named are known to occur, bu these are ones that are naturally associated or closely related in thei more important properties to the types named as the soil group.

In the key to the soil types of the state presented in anothe section of this bulletin, the soil group on which these various type may be expected to occur is indicated by the appropriate lette symbol.

Gloucester fine sandy loam group. (Map symbol G.) Thes soils are developed on more or less hilly topography. Boulder and angular rock fragments are always present, but not sufficientl numerous to prevent the improvement of 30 per cent or more o the total area. They are light-textured, medium brown surfac soils, with light yellow-brown subsoils developed from moderately deep, stony, coarse and uncompacted glacial till of predominantly grayish color.

As the map indicates, they include the soils of most of the Eastern Highland, and of the southern and western portion of the Western Highland. Rock outcrop frequently occurs. Boulders

are frequent, although the more stony areas are assigned to the Stony Soil Group. Cultivated fields were formerly much more stony, but have been partially cleared of stone to be utilized as fences or road material. The rock material is predominantly gray in color, due to the high percentage of quartz and light-colored feldspars.

Underdrainage is rapid because of the open, porous character of the underlying material. Surface drainage is excellent, due to the irregularly hilly topography. The surface and subsoil are of fine sandy loam, or more rarely, a light loam texture, giving good mechanical condition.

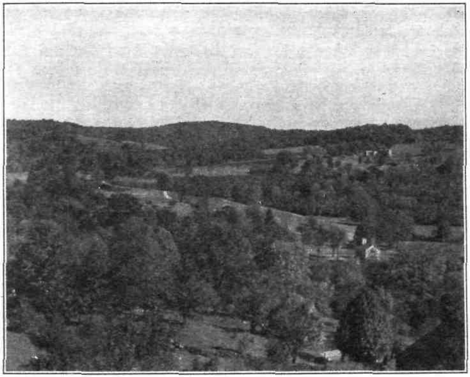

FIGURE 61. Typical landscape of the Western Highland, with Charlton soils on the hills in the background, Hinckley soils on the low gravelly knolls in the middle distance, and irregular slopes with Gloucester soils in the foreground.

When not too stony for easy cultivation, good yields of corn, potatoes and vegetable crops are obtained. Grass hay is the chief crop, although yields are light and of poor quality because of the leachy character of the soil. Fields are of small size, and difficult to operate on account of frequent large boulders and the irregular surface. The wooded portion and much of the pastured area of the farms are usually quite stony.

Charlton loam group. (Map symbol C.) Such soils occur on the more smoothly rolling hills of the Eastern and Western

Highlands. Large boulders and rock fragments of various size may be found, but are usually less abundant than in the Gloucester fine sandy loam group. The surface soils are grayish-brown loams and fine sandy loams, with yellowish-brown, yellowish-olive or light brown subsoils of slightly heavier texture, developed over deep, very compact glacial till ("boulder clay" or "hard-pan") of yellowish-olive, grayish-olive, or light brown color, containing from five to fifteen per cent of actual clay in most cases. The presence of this sort of substratum within about two feet of the surface has a marked effect in decreasing the rapidity of under-drainage and the retentiveness of the soil for moisture and soluble plant nutrients. Reasonably favorable topography and degree of stoniness permit larger fields upon which modern tillage and harvesting machinery can be used. In many cases the soils are slow to dry out and warm up in the spring and are regarded as "late" for some market garden crops. Commercial orcharding is extensively followed, but dairying is the leading enterprise, as a result of the favorable conditions for grass hay and silage corn.

The largest areas are in the Western Highland, although commonly occurring in the vicinity of Woodstock, Pomfret and Lebanon, as well as locally in several other eastern Connecticut towns.

Wethersfield loam group. (Map symbol W.) Over the hilly portion of the central lowland of Connecticut, the soils are closely related to the reddish-colored sandstones and shales which here form the bedrock material. Slabs and chips of this rock are common in the soil, but large boulders are of infrequent occurrence. A reddish cast is commonly observed in the brown color of the surface soil. The subsoil is reddish yellow-brown or red-brown, over a thick and usually compact substratum of sandy loam or sandy clay, which contains much decomposing red sandstone and shale material.

The topography is usually favorable for cultivation and a wide range of crops is commercially grown. Market gardening, dairying and orcharding are equally successful, while there is some use of these soils for tobacco in the Hartford County tobacco district.

Dover fine sandy loam group. (Map symbol D.) In the limestone areas of northwestern and western Litchfield County and in northwestern Fairfield County on the rolling hills overlying such formation, a sufficient amount of lime exists in the parent material to form soils that are noticeably less acid than is natural for other soils of the state.

The surface soils are of a medium brown color, with yellow-brown subsoils over a rather sandy substratum containing noticeable amounts of disintegrating white marble fragments. There are usually some boulders of gneiss and schist rocks, and the areas

also include many soils of the general type described as Charlton fine sandy loam. Exposed limestone ledges occasionally prove an obstacle to cultivation, but on the whole the soil is of excellent character for hay and corn, vegetable crops, potatoes and grazing.

Hollis loam group. (Map symbol I.) These soils occur only in the towns of Woodbridge, Orange and Milford, where they are closely associated with the underlying bedrock of phyllite and chlorite-schist. The topography is gently to strongly rolling. Boulders are infrequent, although the soils contain many "chips" of shale and slate fragments of a dark bluish or greenish-gray color. The surface soils are dark grayish-brown, with yellowish-olive subsoils over glacial till and weathered bedrock composed chiefly of a mass of dark gray shale and slate fragments. The soils are heavier in texture than most other upland soils of the state, heavy loams and silt loams being the rule. They are well adapted to grazing, hay and corn, although usually heavy lime and fertilizer applications are required.

Enfield very fine sandy loam group. (Map symbol E.) In certain towns of Hartford County, especially in Enfield, East Windsor, South Windsor and East Hartford, there are low, rolling hills of a soil of exceptionally fine sandy texture. The material forming this soil is believed to have been deposited by wind action during a period at the close of the ice age, laid down as a layer from two to five feet thick of very fine sand and silt over the older surface, which was either compact glacial till or water-deposited sand and gravel. From such deposits a soil has been formed that is entirely free from coarse sand, gravel, or stone, and that contains an unusual proportion of very fine sand. The surface soil is light brown in color, while the subsoil is grayish-yellow-brown. There is a complete absence of stone, gravel and coarse sand in both surface and subsoil, although the underlying substratum may be quite stony or gravelly. Such a soil has an almost ideal physical condition, being quite absorbent of moisture, easy to cultivate, and with adequate fertilization high yields of crops of excellent quality are obtained in years of normal rainfall. A very high percentage of the soils is in cultivation. Tobacco is especially favored. Good results are obtained with both vegetable crops and general field crops. Exceptionally good potato fields are found on these soils. The humus content is somewhat lower than for most other soils of the region.

Manchester sandy loam group. (Map symbol N.) These soils occur in the Central Lowland division of the state with considerable areas in many towns. They are most often associated with the smaller valleys, but commonly occur on belts of strongly rolling to irregularly hilly relief, which follow the same general topographic level for many miles as fringes around the main

drainage basins of the Connecticut, Farmington and Quinnipiac rivers.

The typical condition is a moderately gravelly sandy loam surface of dark brown color, with reddish yellow-brown subsoil, over coarsely stratified sand and gravel of light reddish-brown color, composed chiefly of red sandstone and shale material. When not too steep or gravelly, the Manchester soils are well suited to tobacco, early vegetable crops and potatoes. Corn does fairly well when heavily fertilized. Grass hay and pasture sods are commonly thin as compared to the less leachy "Wethersfield" soils of the region.

Hinckley gravelly sandy loam group. (Map symbol H.) These soils are very common in both the Eastern and Western Highlands, but find their most extensive development in the Quinnebaug and Natchaug valleys. They occur in narrow belts or isolated patches at varying heights above drainage levels in practically every sizable valley in the highlands. The topography is frequently quite irregular but as a rule they occur along the same general level in any particular valley. No large boulders occur, but rounded "cobbles" of considerable size are common.

The surface soil is brown in color, with a yellow-brown sandy and gravelly subsoil, over a coarsely stratified sand and gravel substratum composed chiefly of igneous and metamorphic rocks.

The texture of the soil is quite variable and a single small field may include a half dozen different soil classes. Normally the more gravelly and sandy soils occur on the knolls, while more loamy soils of darker color are to be found on the lower slopes and depressions.

Where the land surface is not too steep and the fields include only small patches of the excessively gravelly or sandy types, these soils are well suited to early crops. Field corn and grass hay are severely injured by drouths and alfalfa is the most promising hay crop. Pasture herbage is thin, and the soil is too leachy in character to give hope of satisfactory top-dressing results.

Merrimac coarse sand group. (Map symbol Z.) Such soils occur chiefly on the broad flat terrace lands in Windsor Locks, East Granby, Granby, Windsor, Suffield, Enfield, Wallingford, North Haven, North Canaan and Canaan, with a few smaller areas in other parts of the state. A medium to dark brown surface soil, of coarse sandy texture, with a yellow-brown coarse textured subsoil is formed over a substratum of stratified sand and fine gravel of light grayish-brown color.

The excessively sandy character of such soils makes moisture a serious limiting factor in dry seasons. In wet seasons soluble nutrients are leached out so rapidly that it is difficult to furnish the crop with adequate amounts of fertilizer. Tobacco under

shade is a successful crop in the Hartford County areas on the more favorable soils, while much of the land is overgrown with scrub oak, gray birch and pitch pine.

Merrimac sandy loam group. (Map symbol M.) These types occur on the level terrace lands of the Farmington and Connecticut valleys in Hartford County. They have medium brown surface soils of moderately sandy texture, with yellow-brown, slightly heavier subsoils developed over a well stratified sand and gravel substratum of grayish brown color composed chiefly of granitic material. The texture is highly favorable for the production of cigar leaf tobacco of excellent quality with the heavy fertilization usually practiced in this state. Early vegetables do well. Potatoes may suffer severely from dry seasons. Corn makes large yields, particularly on land with an accumulation of fertility from previous tobacco fertilization. Grass hay crops are short-lived, due to the sandiness of the soil. Alfalfa is a promising forage crop. The topography and character of the soil are less favorable for orchard fruits than on the upland soils of the state.

A high percentage of these soils is in cultivation.

Merrimac fine sandy loam. (Map symbol L.) These soils occur as terraces in the valleys of most of the important streams of the Eastern and Western Highlands, and as broader level areas along the borders of Long Island Sound in many of the shore towns. The surface soil is medium brown in color, of fine sandy loam and loam texture, with yellow-brown gravelly loam subsoil over a stratified gravel and coarse sand substratum of grayish brown color. They are favored for market gardening, trucking and potato growing, while the soil is sufficiently loamy to permit the growing of most general farm crops. Tobacco is the common crop in Hartford and Litchfield counties. Grass hay is less successful than on the upland soils. A considerable portion of these areas is occupied by cities, villages and shore resorts.

Hartford sandy loam group. (Map symbol R.) These soils occur as terraces along the smaller streams of the central lowland, adjacent to upland soils of the Wethersfield loam group. They are most extensively developed in New Haven County.

The surface soils are usually slightly gravelly, of dark reddish-brown color, with reddish-brown or reddish-yellow subsoils formed over well-stratified coarse sand and gravel composed chiefly of red sandstone and shale material. Under average conditions the Hartford soils are excellent for market-gardening, since they combine the qualities of "earliness," good drainage, and favorable topography, while a reasonably good moisture-holding capacity is favored by a somewhat higher humus and clay content than is usually found in sandy loam soils. Tobacco is grown over most of the areas of these soils that occur in the tobacco district.

Suffield clay loam group. (Map symbol F.) These soils are formed from deposits of clay laid down at the close of the ice age in certain areas in Hartford, Middlesex and New London Counties, chiefly in Suffield, Enfield, East Windsor, Windsor, Hartford, Berlin, Middletown, and North Haven. (The clays in the last three towns are of a reddish-chocolate, while the more northern deposits are of a drab color, with a corresponding difference in the soils derived from them.) They are light grayish-brown or light reddish-brown surface soils of silt loam or clay loam texture, with light grayish-brown, light olive-drab, or reddish-brown subsoils, developed over laminated clay of drab or reddish-chocolate color. The soils are entirely free from stony gravel or coarse sand.

The topography is level except along ravines where the streams have eroded through the clay beds. Drainage is often poor, except on the eroded slopes. They are difficult to till as compared to other soils of the state, and are most extensively used for hay and pasture. Certain areas where the texture of the surface soil is a very fine sandy loam are occasionally used for tobacco in the Hartford County section, but the heavier Suffield soils produce crops of poorer quality than the sandier soils of the same region.

Podunk silt loam group. (Map symbol A.) The most extensive area of these alluvial soils is on the flood plain of the Connecticut River, popularly known as the "meadows." A few other streams, notably the Farmington River, have flood plains of important extent, while many brooks and small rivers have narrow strips of "bottom-land" at intervals along their course. The surface soils are of a dark grayish-brown, gray-black or dark reddish-brown color, and of texture ranging from fine sand to silt loam. The subsoil is almost identical to the surface soil, usually becoming of a lighter gray somewhat mottled color with increasing depth. A deep substratum of light gray sand is frequently encountered.

The chief value of these soils is in the production of hay crops for long periods with little or no fertilizer treatment. More than 75 per cent of the Connecticut River meadows is in hay, chiefly of native grasses. The narrower bottom-lands of the smaller streams are generally used as pasture, with small areas in hay or corn. The higher-lying, least frequently flooded areas of the Connecticut and Farmington river bottoms are occasionally used for tobacco, corn and vegetable crops.

Whitman loam group. (Not represented on the Outline Map.) In practically all parts of the state there are many small areas of poorly drained upland soils, which occur in land depressions or on slopes that are kept water-logged through seepage. These scattered "spots" of soil, rarely more than a few rods wide, in the aggregate represent nearly one per cent of the total area of the state. Since they never group themselves in large blocks, no

attempt has been made to represent the Whitman soils on the Outline Map. The surface soils are very dark grayish-brown or gray-black in color, with subsoils showing noticeable mottlings of grayish-olive and reddish yellow-brown, as a result of poor drainage conditions. The substratum is usually an olive-gray colored coarse sandy clay in heavy sandy loam containing many rock fragments.

The Whitman soils always contain numerous boulders, unless they have been removed in the clearing of fields that are composed chiefly of better-drained soils. Patches of Whitman soils in such fields can be made quite productive for grass hay and corn if they are artificially drained. Larger Whitman areas have usually been relegated to pasture and woodland, the latter being composed of a strikingly large percentage of red maple.

Muck group. (Map symbol S.) Many land depressions, which were shallow ponds and small lakes for a considerable time after the close of the glacial period, have now become filled. Light gray fine sand and silt accumulated at the bottom of the water, which is now replaced by considerable depths of organic residues of sphagnum moss, sedges and forest debris in varying stages of decomposition.

If the material is thoroughly humified, partially mineralized, and of a nearly black color, it is called "muck." If less completely decomposed, and of a brown color, it is usually called "peat." Since most of such deposits in Connecticut are of the former character, such peat deposits as are known to exist in the state are mapped with the muck.

Both are strongly acid in character, and when drained for cultivation must be heavily limed and manured. Only a few small areas have been thus utilized for agriculture. A couple of generations ago much of the material was used as a soil amendment to add humus to soils that were excessively sandy or that "baked" badly in dry weather. Excessive labor costs have restricted this practice, and it seems probable that most of the muck and peat soils of the state will remain in woodland for some time to come, although they constitute a valuable potential resource for muck crop production, soil amendment and possible use as fuel.

Tidal marsh. (Map symbol K.) All the shore towns have tracts of these tidal marshes. They are never wooded, and are usually covered with sedge and wild grass vegetation. This growth is cut for "salt hay" and is largely used as bedding and packing material. The soil is composed of an admixture of fine silt with the humus remains of the above vegetation. It is impregnated with salt, and contains much lime from shell remains.

The agricultural reclamation of such areas is frequently practicable. It involves the construction of dikes (usually short in

proportion to the area reclaimed, since most of the marshes are fringed with natural sea walls in the form of coastal sand dunes), tide-gates, and a few large drainage ditches. The salt is leached out rapidly after permanent drainage of the marsh and most crops could safely be grown within three years. When economic conditions demand their utilization, many of these tidal marshes may prove a valuable agricultural asset, rather than continue to furnish a constant mosquito-control problem, as is now the case. In the meantime areas near population centers are being developed for factory and airport sites.

Holyoke stony loam group. (Map symbol T.) The trap rock ridges which are a conspicuous feature of the landscape in central Connecticut, while showing abrupt cliffs along their western face in most cases, are elsewhere covered to a rather shallow depth by these stony soils. The surface soil is a dark reddish-brown loam containing many angular fragments of trap rock. The subsoil is a reddish yellow-brown, very fine sandy loam, over either bedrock or a substratum of loose trap fragments usually more or less mixed with red sandstone and shale material.

Practically all such soils are in woodland, although a few of the smoother and less stony areas have been cleared for pasture.

Miscellaneous stony soils. (Map symbol X.) For the purposes of the Outline Map, all areas besides the Holyoke with a predominance of soils that are too stony for economic cultivation have been grouped together under this head. However, it is desirable that these be briefly described under several distinct headings, or sub-groups.

Sub-Group X-1. Stony Soils of Light Texture, with Perfect Surface Drainage and Rapid Underdrainage

Soils of this character form the highest percentage of both the Eastern and Western Highlands. They are developed on hilly or mountainous topography. In northern and eastern Litchfield County, northern Tolland County, eastern and southwestern New London County, southern Middlesex County, western New Haven County and northwestern Fairfield County the area is chiefly of this type, while considerable tracts of such land occur in almost every one of the highland towns.

The typical soil is the one described in detail later as the Gloucester Series, of which the Gloucester stony fine sandy loam is the most common type. The surface soil, in its virgin condition in the forest, consists of a thin layer of slowly decomposing leaf mold, resting upon a four or five inch layer of grayish yellow-brown fine sandy loam. When disturbed by the plow, this forms a six or seven inch horizon of medium brown fine sandy loam.

The subsoil, to the depth of about thirty inches, is a light yellow-brown fine sandy loam of friable consistency. Below this is to be found a coarse, rather loose and open mass of boulders, smaller rock fragments, sand and a relatively small percentage of silt and clay. The color of this material is predominantly gray. There are many boulders, from 20 to 50 per cent of the surface being occupied by stones more than eight inches in diameter. Small isolated fields have been partially cleared of stone by the herculean labors of the early settlers, who failed to realize that better land was to be found which could be brought under the plow with infinitely less exertion.

Other soils of similar characteristics are the stonier types of the Brookfield, Hinsdale, Maltby, Wilton, Coloma and Plymouth series. There is less than 10 per cent of improved land on such soils. These are located in small uneconomic units. Even when partially cleared of stone, the crop production is low, due to high acidity, general deficiency in available plant food material, excessive leachiness and poor drouth resistance.

From ten to 15 per cent of these soil areas are used for permanent pasture, practically all of which is of low grade. The edible native grasses, chiefly Rhode Island bent and redtop, make slow and irregular growth on account of adverse soil reaction, low fertility and severe dry weather damage, thus rapidly losing ground in competition with moss, cinquefoil, poverty grass, and dewberry vines. Bushy clumps of bayberry, sweetfern, juniper and sumac rapidly encroach on the open spaces. Gray birch or red cedar find excellent conditions for propagation, and unless heavily overgrazed or kept clear at great expense, the land rapidly reverts to these old field conditions, from which it is but a step to complete reversion to forest.

Eighty per cent or more of these soil areas is now occupied with some sort of woodland, much of which is of low grade. The chief reasons for the poor productivity of this land are as follows:

1. Being once cleared for tillage and pasture for considerable periods, the natural conditions of the forest soil have been destroyed. The fibrous organic matter of the original leaf mold has been broken up, and the soil reverting to woodland is in poor physical condition. The readily available food materials in this organic matter were dissipated, and the organic matter remaining in the soil is the residue that decomposes with difficulty.

2. The species predominating in unmanaged recently reverted stands are of undesirable type.

3. Areas have been repeatedly clear cut for firewood. The soil has been compacted through the beating action of rains and the breaking down of the normal crumb structure as a result of the reduced buffering effect of the leaf mold. Rapid decomposition

of organic matter and loss through excessive leaching occurs during the frequently recurring periods when the forest soil lies exposed.

4. Frequent and severe fires have consumed the natural humus conditions of the forest soil, and have destroyed the seeds furnishing reproduction for the best species.

Large areas of valuable forest also occur, when the removal of the virgin stand has been followed by wisely managed tree production, carefully guarded against fire and not subject to clear cutting for firewood as often as trees of from four to six inches in diameter are available. With adequate fire protection, the systematic weeding for firewood of the undesirable forest species, and a state taxation policy that encourages the landowner to permit the better species to grow to maturity, soils of this type will eventually be restored to their true conditions of productivity.

Sub-Group X-2. Stony Soils of Medium Texture, with Good Surface Drainage and Moderately Slow Underdrainage

Such soils constitute a considerable area of the highland regions of the state. They are most extensively developed in the northwestern part.

The typical soil is the Charlton stony loam. The surface soil in its virgin condition in the forest consists of a thin layer of well decomposed leaf mold resting upon a mellow, dark grayish-brown loam from three to four inches thick. Below this is a light grayish-brown fine sandy loam three or four inches in depth. The subsoil, to a depth of about 20 inches from the surface, is a grayish yellow-brown fine sandy loam of rather firm consistency. The substratum is a very compact grayish to yellowish olive-colored mass of sand and irregular rock fragments, with a considerable amount of silt and clay.

Other soils of similar characteristics except for minor color differences and of varied types of parent rock material are the stony types of the Dutchess, Hollis, Taugwank, Bernardston, Paxton, Woodbridge, Haddam and Litchfield series.

The percentage of cultivated land on such soils is also very small (less than 10 per cent), but their superior character for permanent pasture has resulted in an extensive use for this purpose estimated at from 20 to 30 per cent of the total area. Long periods of grazing without any attention to fertility maintenance has usually left such pastures in a low productive condition, except where used as night pasture with heavy barn feeding. There is a sparse growth of red top or Rhode Island Bent, some blue grass and white clover. Moss, cinquefoil, sumac and steeplebush are very prevalent. In northern Litchfield County the shrubby cinquefoil, ***potentilla fructosa,*** is a common pasture pest.

Pastures on these soils may be greatly improved by topdressing with superphosphate and lime and on more intensively grazed areas should also receive potash and nitrogen in the fertilizer treatment.

From 60 to 70 per cent of the soils of this group are in brush or woodland. More than 20 per cent of this is accounted for as areas previously kept clear for pasture. Recent changes in economic conditions have caused many former pasture fields to be permitted to grow up to brush.

In general, 50 per cent or more of the above soil group is in hardwood forest, usually in small form woodlot tracts. The productive conditions are somewhat better than those previously described for sub-group X-1. The soil has not been as sensitive to poor forest management, and perhaps in general there has not been the repeated clear cutting on the farm woodlot type of holdings as has been practiced on forest areas not in farms.

Sub-Group X-3. Rough Stony Land

This simple designation applies to a considerable area well distributed over the highland regions of the state, where the surface is so rough and broken in topography, or so completely strewn with large boulders that the topography and stoniness mask the effects of variations in the soil itself.

Practically all such land is in forest, and must remain so, except where the recreational and scenic possibilities warrant the clearing of small blocks for parks or country estates. Except where bedrock outcrops or lies within two feet of the surface, the fine earth among the loose stone is sufficiently deep and otherwise suitable for the maintenance of good natural stands of mixed hardwoods in the southern part of the state, and mixed hardwoods, hemlock and white pine in the northern part of the state. Where the areas have been severely burned, or clear cut repeatedly, the humus conditions of the soil have become unfavorable, resulting in poor growth and a predominance of practically worthless "weed" trees, such as gray birch, scrub oak and pitch pine.

A Key to the Soil Types of Connecticut

(The letter following the name of the soil type indicates the soil group to which it is assigned on the Outline Soil Map.)

a 1. Upland soils, derived from glacial till (unstratified rock debris).
  b 1. Well drained.
    c 1. With loose, coarse and very porous substratum (containing little or no clay) at from 28 to 36-inch depth.
      d 1. Derived from morainal deposits; usually with irregular topography.
        e 1. Rock material: mixed granite gneiss and schist. Light brown surface soil; brownish-yellow subsoil; grayish-yellow and very stony substratum, with many large, irregularly rounded boulders; distribution—in small, isolated areas, chiefly in extreme southeast portion of state.
          f 1. Moderately stony—**Plymouth loamy fine sand** (G).
          Plymouth fine sandy loam (G).
          f 2. Very stony—**Plymouth stony fine sand** (X).
          Plymouth stony fine sandy loam (X).
      d 2. Derived from glacial till overlying practically unweathered bedrock, usually at 10 to 25 feet depth; hilly to mountainous topography.
        e 1. Rock material: grayish-colored granite-gneiss. Medium brown surface soil; yellow brown subsoil; brownish-gray to gray, coarse and stony substratum; distribution—very extensive over both Eastern and Western Highlands.
          f 1. Moderately stony—**Gloucester fine sandy loam** (G).
          Gloucester loam (G).
          f 2. Very stony—**Gloucester stony fine sandy loam** (X).
          Gloucester stony loam (X).
          f 3. Very stony; similar to Gloucester, but showing noticeable grayness in the mineral soil underlying the forest humus when observed under woodland conditions (podsolized).
          —**Hermon stony fine sandy loam.**
      d 3. Derived from glacial till overlying partially weathered bedrock at variable depth, usually less than 10 feet, topography hilly to mountainous.
        e 1. Rock material: light gray quartzite or quartz-schist. Light brown surface soil; light brownish-yellow subsoil; light gray substratum with much fine sand mixed with broken quartzite or quartz-schist rock fragments; distribution—chiefly in extreme eastern portion of state, in Putnam, Killingly and Plainfield.
          f 1. Moderately stony—**Coloma loamy fine sand** (G).
          Coloma fine sandy loam (G).
          f 2. Very stony—**Coloma stony loamy fine sand** (X).
          Coloma stony fine sandy loam (X).
        e 2. Rock material; mica schist. Brown surface soil, with slight reddish coat; reddish yellow-brown subsoil; light yellowish brown substratum consisting chiefly of disintegrating mica-schist; distribution—extensive in many parts of Eastern and Western Highlands especially on stony, non-agricultural areas.

f 1. Moderately stony—**Brookfield fine sandy loam** (G).
Brookfield loam (G).

f 2. Very stony—**Brookfield stony fine sandy loam** (X).
Brookfield stony loam (X).

e 3. Rock material: dark gray granite gneiss, usually with large crystals; medium brown surface soils; yellow-brown subsoil with slight reddish cast; light yellowish-brown to grayish-brown substratum with many slightly discolored, sharply angular rock fragments; not micaceous; distribution — extensive in Eastern Highland, especially west of Connecticut River.

f 1. Moderately stony—**Hinsdale fine sandy loam** (G).
Hinsdale loam (G).

f 2. Very stony—**Hinsdale stony fine sandy loam** (X).
Hinsdale stony loam (X).

e 4. Rock material: dioritic schist with high percentage of hornblende. Dark brown surface soil with slight reddish cast; reddish yellow-brown subsoil; grayish-brown substratum with many nearly black rock fragments; only slightly micaceous; distribution—a few important areas in southern Fairfield County, chiefly in Wilton, Weston and Westport, local in Brookfield and New Milford.

f 1. Slightly to moderately stony—
Wilton fine sandy loam (G).
Wilton loam (G).

f 2. Very stony—**Wilton fine sandy loam** (X).
Wilton stony loam (X).

e 5. Rock material: greenish-gray chlorite schist. Medium to dark brown surface soil; reddish-yellow subsoil, noticeably more sticky when wet than surface soil; light gray to pinkish-gray substratum with much fine sand mixed with disintegrating chlorite rock; distribution—Woodbridge, West Haven and Orange, chiefly on stony, non-agricultural areas.

f 1. Moderately stony—**Maltby fine sandy loam** (I).
Maltby very fine sandy loam (I).

f 2. Very stony—**Maltby stony fine sandy loam** (X).
Maltby stony loam (X).

e 6. Rock material: bluish-gray phyllite or slate, dark grayish-brown surface soil; yellow-brown to olive-drab subsoil; bluish-gray substratum consisting chiefly of a soft mass of disintegrating phyllite or slate; distribution—Bethany, Woodbridge, Orange, Milford, and Stratford.

f 1. Slightly to moderately stony—**Hollis loam** (I).
Hollis silt loam (I).
Hollis shaly loam (I).

f 2. Very stony—**Hollis stony loam** (X).

e 7. Rock material: shaly schists. Medium gray-brown surface soil; greenish-yellow to yellowish-olive subsoil; yellowish olive substratum, firm and composed of disintegrating shale fragments; distribution—extreme northwestern part of state in Salisbury and Sharon.

f 1. Slightly to moderately stony—
Dutchess loam (D).
Dutchess silt loam (D).
Dutchess shaly loam (D).

f 2. Very stony—**Dutchess stony loam** (X).

e 8. Rock material: impure limestones and shaly dark olive-brown surface soil. Greenish-yellow subsoil; olive-drab substratum with disintegrating schist and limestone fragments; often somewhat micaceous; distribution—Sharon and New Milford.

f 1. Slightly to moderately stony—
Pittsfield fine sandy loam (D).

f 2. Very stony—**Pittsfield stony fine sandy loam** (X).

e 9. Rock material: principally limestone or marble. Light to medium brown surface soil; yellow to reddish-yellow brown subsoil; light gray to nearly white substratum with disintegrated limestone or marble fragments; distribution—Shawn, upper Housatonic Valley and in vicinity of Danbury.

f 1. Slightly to moderately stony—
Dover fine sandy loam (D).

f 2. Very stony—**Dover stony fine sandy loam** (X).

d 4. Derived from glacial till of variable depth, usually very shallow, overlying practically unweathered bedrock; very rugged topography as a rule; commonly adjacent to steep cliffs without soil covering.

e 1. Rock material; chiefly basaltic or dioritic "trap." Dark chestnut-brown to reddish-brown surface soil; reddish yellow-brown subsoil; grayish to yellowish-brown substratum usually composed chiefly of slightly weathered angular fragments of "trap" rock. Distribution—coincident with the "trap" ridges which rise from the central lowland of Connecticut. The areas are usually of the very stony type.

f 1. Moderately stony—
Holyoke very fine sandy loam (T).
Holyoke loam (T).

f 2. Very stony—**Holyoke stony loam** (T).

e 2. Rock material—massive, coarse, conglomerate sandstone of pinkish-gray color; medium brown surface soil; reddish yellow-brown subsoil; brownish gray coarse gravelly substratum (gravel formed from disintegration of the conglomerate rock); distribution—local occurrence in southern Middletown and northern Durham.

f 1. Moderately stony—**Middletown loam** (W).

f 2. Very stony—**Middletown stony loam** (X).

c 2. With dense, compact glacial till substratum containing a moderate amount of clay (so-called "hardpan").

d 1. Derived from deep glacial till of drumlin or drumloid character; topography well rounded hills of uniform slope; soil and subsoil extend to compact substratum more than 24 inches below surface.

e 1. Rock material: grayish-colored granite gneiss. Grayish-brown surface soil; grayish yellow-brown subsoil; olive-drab substratum, becoming very compact at 28 to 30 inches below surface; distribution—very common occurrence in both Eastern and Western Highlands of the state, particularly in southern portion of Western Highland on the smoother ridge tops.

f 1. Slightly stony—**Woodbridge fine sandy loam** (C).
Woodbridge loam (C).

f 2. Moderately to very stony—
Woodbridge stony fine sandy loam (X).
Woodbridge stony loam (X).

f 3. Moderately to very stony. Similar to Gloucester but showing definite grayness in the mineral soil underlying the forest humus when observed under woodland conditions (podsolized)—
Becket stony loam (X).

e 2. Rock material: mixed granite gneiss and schist. Grayish-brown to dark grayish-brown surface soil; grayish yellow-brown subsoils; yellowish-olive to olive-drab substratum, becoming very compact at 24 to 28 inches below surface; distribution—very common occurrence in Western Highland and particularly in the northern portion of the Eastern Highland, on the more distinctly drumlin type of topography.

f 1. Slightly stony—**Charlton fine sandy loam** (C).
Charlton loam (C).

f 2. Moderately to very stony—
Charlton stony fine sandy loam (X).
Charlton loam (X).

e 3. Rock material: quartz-schist, quartzite or granite gneiss containing much quartz. Dark grayish-brown surface soil; grayish yellow-brown subsoil becoming slightly mottled at 18 to 24 inches; gray to olive-gray substratum of very compact character at 28 to 30 inches below surface; distribution—chiefly in southern Windham County, on the flatter ridge tops.

f 1. Slightly to moderately stony—
Taugwank fine sandy loam (C).
Taugwank loam (C).

f 2. Very stony—**Taugwank stony loam** (X).

e 4. Rock material: dark gray granite gneiss, containing many crystals of biotite and hornblende. Medium brown surface soil; light brown subsoils; light brown to grayish-brown substratum, occasionally with a slight "pinkish" cast, becoming very compact at 28 to 30 inches below surface; distribution—principally confined to that portion of Eastern Highland that lies in Middlesex and New Haven Counties, on smoothly rolling ridges adjacent to rougher areas of soils of *Hinsdale* types.

f 1. Slightly to moderately stony—
Haddam fine sandy loam (C).
Haddam loam (C).

f 2. Very stony—**Haddam stony fine sandy loam** (X).
Haddam stony loam (X).

e 5. Rock material: bluish gray phyllite or slate. Dark olive-brown surface soil; dark olive-drab subsoil; "bluish" olive substratum consisting of a compact mesa of disintegrated chips of phyllite or slate at 24 to 28 inches below surface; distribution—confined to Bethany, Woodbridge, Orange and Milford on drumlin hills adjacent to areas of *Hollis* soils.

f 1. Slightly to moderately stony—
Bernardston loam (I).
Bernardston silt loam (I).

e 6. Rock material: impure limestones and shale. Grayish brown surface soil; yellow-brown to greenish-yellow subsoil; olive-drab substratum, compact at 24 to 30 inches from surface, and containing some limestone fragments; distribution—Sharon and New Milford.

f 1. Slightly to moderately stony—
Lenox fine sandy loam (D).
Lenox loam (D).

f 2. Very stony—**Lenox stony fine sandy loam** (X).
Lenox stony loam (X).

e 7. Rock material: reddish-brown to reddish-gray coarse textured sandstone. Medium-brown surface soil; slightly reddish yellow-brown subsoil; light reddish-brown to reddish-gray substratum consisting of a compact, sandy mass of disintegrating sandstone fragments; distribution—very common on the hilly portion of the central lowland.

f 1. Slightly to moderately stony—
Cheshire sandy loam (W).
Cheshire fine sandy loam (W).
Cheshire loam (W).

f 2. Very stony—**Cheshire stony fine sandy loam** (X).
Cheshire stony loam (X).

e 8. Rock material: brownish-red fine textured sandstone or shale. Reddish-brown surface soil; light reddish-brown subsoil; brownish-red substratum consisting of a very compact mass of disintegrating sandstone and shale fragments; distribution—very common on the hilly portion of the Central Lowland.

f 1. Slightly to moderately stony—
Wethersfield fine sandy loam (W).
Wethersfield loam (W).
Wethersfield clay loam (W).

f 2. Very stony—**Wethersfield stony loam** (X).

d 2. Derived from very deep glacial till of drumlin character; topography—elongated hills of distinctly rounded surface; soil and subsoil extend downward to very compact substratum at less than 24 inches below surface.

e 1. Rock material: schists, gneiss and slates. Olive-brown surface soil; yellowish-olive to olive-drab subsoil; olive-drab substratum of very compact glacial till at from 16 to 20 inches below surface. Good drainage as a result of sloping land surface in spite of slowness of underdrainage; distribution—in many parts of the Eastern and Western Highlands, on the crests of the more perfectly shaped drumlin hills.

f 1. Slightly to moderately stony—
Paxton fine sandy loam (C).
Paxton loam (C).

e 2. Rock material: chiefly of schistose character. Dark grayish-brown surface soil; yellowish-olive subsoils, usually heavier in texture than surface soil; olive-drab to grayish-olive substratum of very compact glacial till at from 18 to 24 inches below surface; drainage slow in early spring, due to moderately level topography and compact substratum at shallow depth; distribution—on the broad, flatter-crested drumlin ridges in central Litchfield County.

f 1. Slightly to moderately stony—
Litchfield fine sandy loam (C).
Litchfield loam (C).
f 2. Very stony—**Litchfield stony loam** (X).
b 2. Imperfectly drained upland soils.
c 1. With temporarily high water table in spring due to excessive seepage from adjacent higher areas; drainage usually good in late summer and early fall.
d 1. Derived from glacial till of relatively shallow depth (less than 15 feet); topography—lower slopes and bench lands; usually at the head or along margins of hillside ravines.
e 1. Rock material: mixed gneiss and schist. Dark grayish-brown surface soil; yellow-brown subsoil, substratum-mottled gray and rusty yellow grading to light gray at lower depths, and of coarse and stony character; distribution—very general in Eastern and Western Highland.
f 1. Moderately stony—**Peru fine sandy loam** (G).
Peru loam (G).
f 2. Very stony—**Peru stony fine sandy loam** (X).
Peru stony loam (X).
d 2. Derived from deep glacial till of compact character containtaining a considerable amount of clay; topography—level or nearly level portions of broad-crested drumlins.
e 1. Rock material: schist and gneiss, with schist predominant. Very dark brown to gray-black surface soil; olive-drab and moderately compact subsoil; substratum mottled gray and rusty yellow becoming grayish-olive in color at greater depths, very compact; with few stones or boulders, except on surface; distribution—occasional in areas where Charlton and Litchfield soils occupy most of the adjacent area, as in towns of Lebanon, Pomfret, Woodstock and in central Litchfield County.
f 1. Slightly to moderately stony—**Sutton loam** (C).
f 2. Very stony—**Sutton stony loam** (X).
c 2. With high water table during most of the year.
d 1. Derived from glacial till of relatively shallow depth (less than 15 feet); topography—lower slopes, at heads and along hillside ravines, in wider areas along small brooks that do not overflow their banks to form alluvial deposits, and other poorly drained depressions not occupied by deep organic accumulations.
e 1. Rock material: mixed granite gneiss, schist, and other non-calcareous, igneous, or metamorphic rocks. Gray-black surface soil; mottled gray and rusty yellow subsoil; light gray to bluish-gray coarse, stony substratum, occasionally with sandy clay, usually waterlogged at all times; distribution—general in all parts of the Eastern and Western Highland.
f 1. Moderately stony—**Whitman fine sandy loam** (G, C).
Whitman loam (G, C).
Whitman sandy clay loam (G, C).
f 2. Very stony—**Whitman stony loam** (X).

e 2. Rock material: mixed schist and limestone. Gray-black to black mucky surface soil; gray or grayish-olive-yellow mottled subsoils; light gray to bluish-gray calcareous substratum of compact character with few stone or boulders; distribution—a few small areas in Sharon; the upper Housatonic Valley, New Milford and Danbury.

f 1. Slightly to moderately stony—**Lyons loam** (D).

e 3. Rock material: reddish-brown sandstones and shales. Very dark brown surface soil, with a slight reddish cast; mottled light-reddish brown and rusty yellow subsoil; grayish red-brown to pinkish-gray substratum, with sandstone or shale fragments; distribution—in central Connecticut adjacent to *Wethersfield* and *Cheshire* types.

f 1. Slightly to moderately stony—
Whitfield loam (W).
Whitfield clay loam (W).

a 2. Valley soils, developed over stratified glacial rock debris (sand, gravel and clay).

b 1. Well drained.

c 1. With loose, coarse, gravelly and sandy substratum at from 24 to 36 inches depth.

d 1. Derived from kames, eskers and similar deltal deposits of irregular topography.

e 1. Rock material: mixed non-calcareous metamorphic rocks (schists and gneiss). Medium brown surface soil; yellow brown subsoil; brownish gray substratum of coarse sand and gravel; distribution—very general in both the Eastern and Western Highlands, where they form irregular, frequently interrupted belts along the lower slopes of the hills that have a mantle of unstratified glacial debris (till)—most extensively developed in the Quinnebaug Valley.

f 1. Not excessively sandy or gravelly—
Hinckley fine sandy loam (H).
Hinckley sandy loam (H).
Hinckley gravelly fine sandy loam (H).

f 2. Excessively sandy or gravelly—
Hinckley gravelly sandy loam (H).
Hinckley loamy sand (H).
Hinckley gravel loam (H).

e 2. Rock material: schists and phyllite slates. Medium brown surface soil; reddish yellow-brown subsoil; light yellowish-brown to olive-drab substratum chiefly composed of rounded chips of slate and schist; distribution—in Woodbridge, Orange and Milford, adjacent to areas of *Hollis* soils.

f 1. Not excessively sandy or gravelly—
Hancock fine sandy loam (H).
Hancock very fine sandy loam (H).
Hancock loam (H).

f 2. Excessively gravelly—**Hancock gravel loam.**

e 3. Rock material: mixed gneiss, schist and limestone or marble. Brown surface soil; yellow-brown or reddish yellow-brown subsoil; gray sand and gravel substratum, frequently partially cemented together with calcareous material below a depth of four or five feet; distribution—in upper Housatonic Valley and in Danbury, adjacent to areas of *Dover* soils.

f 1. Not excessively sandy or gravelly—
Rodman fine sandy loam (H).
Rodman sandy loam (H).

f 2. Excessively sandy or gravelly—
Rodman loamy sand (H).
Rodman gravel loam (H).

e 4. Rock material—brownish-red sandstones and shales. Medium brown surface soil with slight reddish cast; reddish yellow-brown subsoil; brownish-red substratum of sand and gravel; distribution—common occurrence on areas of irregular hummocky topography in central lowland of Connecticut, adjacent to areas of Cheshire and Wethersfield soils.

f 1. Not excessively sandy or gravelly—
Manchester sandy loam (N).
Manchester fine sandy loam (N).
Manchester gravelly fine sandy loam (N).
Manchester loam (N).

f 2. Excessively sandy or gravelly—
Manchester gravel loam (N).
Manchester loamy sand (N).

d 2. Derived from level or nearly level terraces of sand and gravel deposited at the close of the glacial epoch.

e 1. Rock material: mixed schists and gneiss. Medium to dark brown surface soil; yellow-brown or brownish-yellow subsoil; gray to brownish-gray substratum of well-stratified sand or gravel; distribution—most extensive on the wider terrace lands in Hartford County, and as narrower terraces in many valleys in all parts of the state.

f 1. Not excessively sandy—
Merrimac sandy loam (M).
Merrimac fine sandy loam (L).
Merrimac loam (L).
Merrimac gravelly fine sandy loam (L).

f 2. Excessively sandy—
Merrimac loamy fine sand (M).
Merrimac loamy sand (M).
Merrimac coarse sand (Z).

e 2. Rock material: slates and phyllite. Medium brown surface soil; reddish yellow-brown subsoil; olive-drab or bluish-olive substratum with many rounded chips of phyllite or slate; distribution—in Orange and Milford, adjacent to areas of Hollis soils.

f 1. **Fairlea fine sandy loam** (L).
Fairlea very fine sandy loam (L).
Fairlea gravelly very fine sandy loam (L).

e 3. Rock material: shales and shaly schists. Olive-brown surface soil; yellowish-olive subsoil; grayish-olive substratum of sand and gravel, containing many rounded fragments of shale and schist; distribution—upper Housatonic Valley.

f 1. **Sheffield fine sandy loam** (L).
Sheffield loam (L).

e 4. Rock material: mixed schist, gneiss and limestone. Medium brown surface soil; yellow-brown subsoil; grayish sand and gravel substratum containing sufficient limestone material to show effervescence with hydrochloric acid; distribution—a few small areas on terraces of the Housatonic Valley, adjacent to areas of *Dover* soils.

f 1. Not excessively sandy or gravelly—
Palmyra fine sandy loam (L).
Palmyra gravelly fine sandy loam (L).

f 2. Excessively gravelly—**Palmyra gravel loam.**

e 5. Rock material: brownish red sandstones and shales. Dark brown surface soil, with slight reddish cast; reddish yellow-brown subsoil; grayish-red substratum of sand and gravel, chiefly of sandstone and shale material; distribution—narrow terraces along most streams of the central lowland, excepting the Connecticut River terraces, which are chiefly *Merrimac* soils.

f 1. Not excessively sandy or gravelly—
Hartford sandy loam (R).
Hartford fine sandy loam (R).
Hartford loam (R).
Hartford gravelly fine sandy loam (R).

f 2. Excessively gravelly—**Hartford gravel loam** (R).

c 1. With fine or very fine sand substratum at 24 to 36 inches depth.

d 1. Occurring on level terraces, forming the lowest terrace of the Connecticut River, which lies about 60 feet above sea level.

e 1. Rock material: gneiss and schists. Medium grayish-brown surface soil; brownish-yellow subsoil; gray to olive-gray substratum of fine sand, with little or no gravel; distribution—just above the Connecticut River flood plain in the towns of Suffield and Enfield.

f 1. Not excessively sandy or gravelly—
Agawam fine sandy loam (M).
Agawam very fine sandy loam (M).

d 2. Occurring on rolling topography; fine or very fine sand substratum underlain with reddish-colored sand, gravel or stony till at from three and one-half to five feet depth.

e 1. Rock material: finely divided crystalline fragments deposited by ancient wind action as a thin mantle (three to five feet deep) overlying previously deposited stratified and unstratified glacial debris that is chiefly of red sandstone and shale material. Light brown surface soil with no gravel or coarse sand; grayish yellow-brown subsoil; olive gray fine sand or very fine sand substratum, which changes abruptly at three and one-half to five feet depth to coarser sand and gravel or stony glacial till of red brown color; distribution—in Hartford County, chiefly in towns of Enfield, East Windsor, South Windsor, East Hartford and Suffield.

f 1. Not excessively sandy or gravelly—
Enfield fine sandy loam (E).
Enfield very fine sandy loam (E).

d 3. Occurring on level topography; fine or very fine sand substratum underlain with stratified clay and silt at three and one-half to five feet depth.

e 1. Rock material: finely crystalline fragments deposited by ancient wind action as a thin mantle three and one-half to five feet deep overlying previously deposited stratified clay and silt. Light grayish-brown surface soil, free from gravel or coarse sand; grayish yellow-brown to yellowish-olive subsoil; olive-gray and rusty yellow mottled very fine sand substratum which changes abruptly to clay at from three and one-half to five feet depth; distribution—Hartford County, principally in East Windsor and Enfield.

f 1. Not excessively sandy or gravelly—
Melrose fine sandy loam (E).
Melrose very fine sandy loam (E).

d 4. Occurring on level topography or as eroded terrace slopes; heavy silty clay at 20 to 24 inches depth.

e 1. Parent material: stratified clay and silt of olive-drab color, originally deposited on the bed of extinct lakes existing at the close of the glacial epoch. Grayish-drab surface soil; olive-drab subsoil; olive-drab substratum of clay and silt; distribution—Hartford County, chiefly in Hartford, Windsor, Windsor Locks, Suffield, Enfield, East Windsor and South Windsor.

f 1. Not excessively sandy or gravelly—
Suffield very fine sandy loam (F).
Suffield silt loam (F).
Suffield clay loam (F).

e 2. Parent material: red brown stratified clay and silt. Grayish-brown surface soil; yellowish red-brown subsoil; red-brown substratum of clay and silt; distribution—chiefly in Berlin, Middletown and North Haven.

f 1. **Berlin silt loam** (F).
Berlin clay loam (F).

b 2. Imperfectly drained.

c 1. With coarse gravelly and sandy substratum at 24 to 36 inches depth.

d 1. Occurring on level terrace lands.

e 1. Parent material: sand and gravel of granite gneiss and schist rock. Very dark grayish-brown to gray-black surface soil; grayish-yellow subsoil, somewhat mottled (gray and rusty yellow) and partially cemented together as "iron-hardpan" at 20 to 24 inches depth; mottled gray—rusty yellow substratum of sand and gravel, water-logged during most of the year; distribution—occasional poorly drained spots on terraces of *Merrimac* soils.

f 1. **Scarbro sandy loam** (M).
Scarbro loam (L).

e. 2. Parent material: sand and gravel of red-brown sandstone and shale rock. Dark grayish-brown surface soil; reddish-yellow brown subsoil, grading at 15 to 18 inches to mottled reddish-gray and rusty-brown; reddish-gray substratum of sand and gravel, chiefly derived from reddish-colored sandstone and shale rock; water-logged during most of the year; distribution—occasional poorly drained terrace lands adjacent to *Wethersfield* and *Cheshire* soils in the central lowland.

f 1. **Ellington loam** (R).

c 2. With heavy clay substratum at 20 to 24 inches depth.

d 1. Occurring in poorly drained low-lying areas underlain with clay.

e 1. Parent material: stratified clay and silt of olive-drab color. Gray black to dark grayish-brown surface soil, heavy, mottled olive-gray and rust-brown subsoil; slightly mottled olive-drab clay substratum; distribution—occasional poorly drained areas adjacent to *Suffield* soils in Hartford County.

f 1. **Scantic loam** (F).
Scantic clay loam (F).

a 3. Alluvial soils—periodically overflowed by flood waters of existing streams.

b 1. Well drained.

c 1. With fine sand substratum at 24 to 30 inches depth.

d 1. Occurring on infrequently flooded portions of the flood plains.

e 1. Parent material: river-deposited fine sand. Medium brown surface soil; yellow-brown subsoil; brownish-gray substratum of fine sand; distribution—on the higher portions of the Connecticut River flood plain, and along a few other large streams of the state.

f 1. Not excessively sandy—
Ondowa sandy loam (A).
Ondowa fine sandy loam (A).
Ondowa silt loam (A).

f 2. Excessively sandy—**Ondowa loamy fine sand** (A).

b 2. Imperfectly drained over most of the area (excessively sandy soils sometimes with very rapid drainage).

c 1. With no well defined color differences between soil, subsoil and substratum; substratum at 36 to 40 inches depth, usually composed of fine sand and silt.

d 1. Occurring on frequently flooded portions of flood plains.

e 1. Parent material: stream deposits washed down from areas of granite gneiss and schist. Dark grayish-brown surface soil; grayish-brown subsoil; brownish-gray to grayish-brown substratum of variable character, ranging from silt loam to loamy sand; distribution—most extensive areas lie on the main portion of the Connecticut River flood plain, smaller areas include most of the "bottomland" along other streams of the state.

f 1. Not excessively sandy—
Podunk silty clay loam (A).
Podunk silt loam (A).
Podunk very fine sandy loam (A).
Podunk fine sandy loam (A).
Podunk sandy loam (A).

f 2. Excessively sandy—**Podunk loamy fine sand** (A).
Podunk loamy sand (A).
Podunk sand (A).

e 2. Parent material: stream deposits washed down from areas of red-brown sandstones and shales. Very dark brown surface soil with slight reddish cast; red-brown subsoil; brownish-red substratum of clay, sand or silt; distribution—as narrow "bottomlands" along a number of small streams in the central lowland of the state.

f 1. Not excessively sandy—
Middlefield clay loam (A).
Middlefield loam (A).
Middlefield fine sandy loam (A).

a 4. Organic soils.
b 1. Poorly drained.
c 1. Inland, fresh-water deposits.
d 1. Occurring *in land depressions that receive no alluvial* deposits.
e 1. Organic material chiefly composed of forest leaves, shrubby and herbaceous growth. Humus soil black, mellow, well disintegrated, and extending to a mineral substratum of bluish-gray fine sand at depth ranging from less than two feet to 40 feet or more; distribution—in individual areas from less than acre up to about 500 acres distributed over practically every town of the state.
f 1. Mineral substratum less than three feet below surface—**Shallow muck** (S).
f 2. Mineral substratum three feet or more below surface—**Muck** (S).
e 2. Humus soil of brown color, fibrous, composed chiefly of residues from rushes, sedges and sphagnum moss; mineral substratum usually 25 feet or more below surface except at swamp margins; distribution—occasional small areas, chiefly in the Eastern and Western Highlands.
f 1. **Peat** (S).
c 2. Coastal, salt water deposits.
d 1. Occurring as flat areas, periodically flooded by tidal waters.
e 1. Organic material chiefly derived from "salt marsh" vegetation (sedges predominant), surface layer of grayish-brown fibrous residues; lower layers—brownish-gray to bluish-gray, brown-mottled, silty or sandy clay, high in organic matter, containing a high salt concentration, with some shell-fish remains; distribution—along Long Island Sound and its tidal bays and inlets.
f 1. **Tidal marsh** (K).

a 5. Miscellaneous land areas with no definite soil characteristics.
b 1. Surface almost completely paved with large boulders but with a fair depth of soil lying under and between the rocks—
Rough stony land (X).
b 2. Area practically bare, with bedrock exposed—**Rock outcrop** (X).
b 3. Clean, loose sand fringing exposed shores of Long Island Sound, which are swept by waves, tides and wind—**Coastal beach** (K).
b 4. Sand and gravel areas along rapidly flowing streams which are washed clean of all fine earth material by strong channel currents during flood periods—**Riverwash.**
b 5. Areas built up from an original lower level by the dumping of refuse and excavation earth and stone—**Made land.**
b 6. Areas where soil has been removed, exposing the substratum of sand and gravel for use in building and road construction—**Gravel bank.**

PART II

SOIL AND LAND COVER STUDIES

Fifteen areas typical of soil conditions to be found in various parts of the state and indicated on Figure 62, have been intensively surveyed. Maps were prepared showing all soil types and the distribution of crops, pasture, forest and other land use upon these soils.

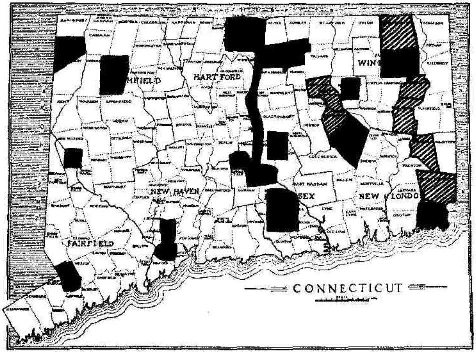

FIGURE 62. Areas over which the soils have been studied in detail. Solid block, soil and land cover surveys for the entire area; shaded, surveys of selected farms within the towns.

In 1928 and 1929, these surveys were supplemented by the results of detailed mapping of the distribution of soils on 190 dairy farms in the towns of Woodstock, Griswold, Coventry, Brooklyn, Columbia, Stonington, North Stonington and Canterbury. These farms are being carefully studied by the Economics Department of the Storrs station, which has also made economic surveys of the Lebanon, Suffield and East Windsor areas, for which soil and land cover maps were prepared.

Complete data as to the details of the distribution of land cover on the soils of these areas is somewhat too voluminous for presen-

tation in this bulletin, but it is hoped that they may be published in their entirety at a later date.

Important soils represented in two or more different areas present a somewhat different picture of land cover, depending upon the relative occurrence of other more or less favorable soils as well as other frequently explicable factors. An example is indicated in comparisons of the results of the land cover tabulation for the less-stony phases of the Gloucester and Charlton soils in the Lebanon, Stonington, Pomfret, Goshen and Wilton areas.

TABLE III. LAND COVER DISTRIBUTION ON GLOUCESTER AND CHARLTON SOILS IN SELECTED AREAS.

	Percentages			
Area and soil	Tilled land and mowing	Open pasture	Brush and "old field"	Hardwood forest
Lebanon-Gloucester	30.9	19.7	5.5[1]	43.9
Charlton	50.0	26.7	2.8[1]	20.5
Pomfret-Gloucester	30.9	5.0	28.9	35.2
Charlton	54.8	6.76	15.3	23.2
Goshen-Gloucester	48.5	28.9	6.5	16.0
Charlton	56.5	16.5	10.9	16.1
Wilton-Gloucester	43.9	8.7	27.0	20.4
Charlton	56.1	15.9	18.6	9.4
Stonington-Gloucester	57.6	5.0	23.0	14.4
Charlton	62.5	5.8	24.2	7.5

In every area Charlton soils show a higher percentage of tilled land and mowing than Gloucester, yet in towns such as Stonington, with an abnormally large area of extremely stony soils, an unusually high percentage of the small areas of the less-stony phases is in crop production.

The effect of other factors than soil is observed in the land cover distribution in the Goshen area, with respect to open pasture and brush lands. In this town, pastures are quite commonly infested with shrubby cinquefoil (*Potentilla fructosa*) which is much more prevalent on the Charlton pasture areas than on the "drier" Gloucester soil. Summers are cooler and as a consequence Gloucester pastures suffer less severely from dry seasons in Goshen than they might in Stonington. Therefore an unusually high percentage of open pasture is indicated for the Goshen Gloucester soils while the Charlton soils are there so difficult to keep clear of the shrubby cinquefoil that an abnormal portion of the pastures is grown up to brush land or abandoned to gray birches.

In spite of the failure to obtain strictly comparable results in all cases, a tabulation of the data by important soil groups for all of the areas reveals certain important adjustments of land use to the character of the soil.

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[1] "Old field," or gray birch areas, were mapped with the woodland in the Lebanon area.

As would be expected, the more adverse stony and poorly drained soils have largely gone out of cultivation. This is shown by the following table:

TABLE IV. LAND COVER ON STONY AND POORLY DRAINED SOILS.

Soil types	Percentages — Tilled and mowed	Open pasture	Brush land "old field"	Forest
Holyoke stony soils	1	2	1	96
Brookfield Hinsdale stony soils	3	5	5	87
Gloucester stony soils	7	11	16	66
Charlton stony soils	12	21	23	56
Whitman loam (poorly drained)	18	18	20	56
Muck	11	10	23	56

Other soils, with adverse factors depending upon texture, water-holding capacity and general fertility exhibit marked differences in land cover distribution.

TABLE V. LAND COVER ON IMPORTANT AGRICULTURAL SOILS.

Soil types	Percentages — Tilled and mowing	Open pasture	Brush and "old field"	Forest
Enfield v. f. s. l.	70	3	3	24
Merrimac sandy loam	61	8	3	28
Wethersfield f. s. l. and related soils	60	8	5	27
Merrimac fine sandy loam	58	11	8	23
Charlton loam and related soils	56	13	13	28
Suffield silt and clay loam	53	26	3	18
Merrimac coarse sand	44	0.25	8.75	47
Gloucester f. s. l.	36	17	10	37
Podunk loam[1]	34	21	8	37
Hinckley gravelly sandy loam	33	11	25	31

In the tobacco district, two areas have shown that this crop is largely confined to certain soil types. The selection of these soils for tobacco is shown in Table VI.

TABLE VI. TOBACCO ON SOILS OF THE SUFFIELD AND EAST WINDSOR AREAS.

Soil type	Percentage of cultivated area in tobacco
Merrimac sandy loam	52
Merrimac coarse sand	45 (shade)
Enfield v. f. s. l.	40
Manchester gravelly fine s. l.	33
Wethersfield and Cheshire f. s. l. and loam	26
Podunk f. s. l. and loam	20
Suffield silt and clay loam	12

A study of the distribution of commercial apple orchards has shown that these are confined largely to the Charlton and Wethers-

[1] Not including Connecticut River "meadows," which is almost entirely used for native grass hay.

field groups. It is significant that in spite of the large areas of the Gloucester and Merrimac groups of soil, practically no commercial orchards are located upon them.

General Development of Productive Farm Enterprises on Important Soil Types

Dairying. This enterprise, as now being conducted, should prove most successful on lands well suited to the production of silage, hay crops, and pasture. The Charlton, Dover, Wethersfield and Suffield groups of soils most nearly meet these requirements. In spite of the adverse economic conditions that now place Gloucester soils under a serious handicap, dairying still remains the chief enterprise on most of that group. Special local markets have enabled many farms lying chiefly on the adverse sandy Merrimac types to continue to follow dairying as a major pursuit.

Orcharding. As already mentioned, commercial orchards reach their best development on the Wethersfield and Charlton soils. Small home orchards may prove successful on the Gloucester soils, but are generally less satisfactory on the Merrimac, Hartford and Hinckley series.

Small fruits. The chief culture of small fruits is on the Manchester, Hartford and Wethersfield series, and to a slighter extent on the Merrimac and Gloucester series.

Vegetable crops. The sections of most intensive commercial vegetable production are on the Merrimac sandy loam and fine sandy loam, Hartford, Wethersfield and Manchester series. In the vicinity of cities and towns where these soil types are not available, the Gloucester and the less-gravelly phases of Hinckley soils are brought into use. The heavier Charlton and Suffield soils are not able to compete favorably with the lighter soils on a commercial basis.

Potatoes. The most favorable potato soils are probably the Merrimac sandy loam, Merrimac fine sandy loam, Enfield, Manchester and Hartford series, as well as the lighter phases of the Wethersfield and Charlton series. The Gloucester and Hinckley soils, due to their irregular topography and the high percentage of stone and gravel in the soil, are unfavorable for the special planting, spraying, and harvesting machinery that must be used.

Tobacco. The most important tobacco soils, as has been shown by data already given, are the Merrimac sandy loam and fine sandy loam, the Enfield very fine sandy loam, the Manchester fine sandy loam, and to a less extent, the Wethersfield and Cheshire fine sandy loams. The Merrimac coarse sand, when not too excessively sandy, is suited to the production of shade tobacco, but is of little value for the sun-grown crop.

Alfalfa. When properly limed and fertilized, alfalfa may be produced successfully on almost all the well-drained soils. The heavier phases of the Charlton and related series might produce some winter killing. The Gloucester, Hinckley and sandy Merrimac soils, although capable of producing good alfalfa, will probably be less used for this purpose because of the smaller development of the dairy industry upon them.

Grass hay. The heavier upland soils, chiefly of the Charlton group, will stand preeminently as best suited for grass hay. The Wethersfield, Dover and Suffield soils are probably next in order. The Gloucester soils will be kept in grass hay for much of the time, in spite of their lower productivity. Their difficulty of cultivation discourages their use for tilled crops except when the land is not absolutely required in order to furnish sufficient corn silage to support the small-scale dairies that are usually found on these soils. The grass hay crop is thin and shortlived on the sandy or gravelly soils of the Merrimac, Hartford, Manchester and Hinckley series. The alluvial Podunk soils, when not too poorly drained, are well adapted to the production of grass hay.

Corn. The corn crop, except for a few centers of seed production, is closely related to the demands of the dairy industry and the largest utilization of land for the corn crop will be on the Charlton, Wethersfield, Hollis, Dover and Suffield soil groups. The present practice of heavy manuring, if supplemented by adequate commercial fertilizers, should produce good corn crops on a wide range of soils.

Pasture. The Charlton, Suffield, Dover and Wethersfield groups are capable of producing good pasture, especially when improved by top-dressing treatments. The Gloucester areas now in pasture are excessively leachy and otherwise possess lower natural fertility, besides being so stony and irregular in topography that improvement is difficult. They cannot be plowed up for reseeding, and results of top dressing on such soils show little improvement, perhaps due to the excessively leachy character of the soil. The gravelly and sandy soils such as the Hinckley and Merrimac are very low grade pasture producers.

Forest. The larger areas of forest land are obviously to be found on the stony and rough areas. The Gloucester stony soils, the closely related Hinsdale and Brookfield series, and the Holyoke soils of the trap rock ridges are predominant on all the large forests of the state. Smaller areas of woodland cover from 10 to 50 per cent of other soil types. The use of the better agricultural soils for forest is dependent upon local topographic irregularities, inaccessibility of location and economic conditions that do not favor the utilization of all the better areas for crops or pasture. The stony tendency of pasture areas to revert to woodland when not cleared by now expensive labor, is an important factor which fre-

quently operates on even the best soils for pasture production. Some of the better soils may be cleared anew, but at the same time areas of the excessively stony, gravelly and sandy soils should logically revert to forest, through either natural or artificial methods. More than 50 per cent of Connecticut is absolute forest land; probably 15 per cent is of marginal type, the use of which for forest will depend upon fluctuating economic conditions. Problems relating to the proper use of soils for the various forest types are being jointly investigated by the Soils and Forestry Departments, and the present status of these studies will appear in a bulletin now in preparation.

Land utilization for purposes other than agriculture: While such use is not directly related to soil, there are cases where it may become a factor. Most towns and cities occupy land of favorable topography and drainage, and hence compete with agriculture for some of the best land. Recreational land, on the other hand, is rarely good farm land in this region, since rugged wooded hills, rocky shores and forest-circled lakes are the favored sites for park purposes. Country estates, golf courses, polo fields and the usual divertisements of the well-to-do are taking up an increasing proportion of our better agricultural land, particularly in Fairfield County, some parts of Litchfield County, and some of northeast Windham County, as well as the vicinity of our larger cities.

As a result of these surveys supplemented by reconnaissance work over the entire state, we have prepared the following table, which gives a general picture of the relative importance of the various soils for different land uses:

TABLE VII. ESTIMATED AREA AND LAND USE OF CONNECTICUT SOILS, A.

Soil names	Crop	Pasture	Wooded	Urban, etc.	Total	%
Gloucester, Coloma, etc.	A.	A.	A.	A.	A.	
f. s. l. and l.	65,000	40,000	155,000	10,000	270,000	8.7
stony phases	30,000	105,000	560,000	10,000	705,000	22.6
Brookfield, Hinsdale, etc.						
l. and f. s. l.	7,000	5,500	16,500	1,000	30,000	1.0
stony phases	10,000	40,000	394,000	6,000	450,000	14.4
Dover, Lenox, etc.						
f. s. l. and l.	12,000	8,000	5,000	2,000	27,000	0.9
stony phases	500	3,500	1,500	500	6,000	0.2
Charlton, Hollis, etc.						
l. and f. s. l.	185,000	85,000	85,000	35,000	390,000	12.5
stony phases	20,000	52,500	70,000	7,500	150,000	4.8
Wethersfield, Cheshire, etc.						
l. and f. s. l.	150,000	40,000	50,000	60,000	300,000	9.7
stony phases	500	5,000	28,500	2,000	36,000	1.2
Whitman, Peru, etc.						
l. and f. s. l.	4,000	8,000	8,000	1,000	21,000	0.7
stony phases	2,000	12,000	38,000	2,000	54,000	1.8
Hinckley, Manchester, etc.						
gravel and sand	3,000	6,000	14,000	10,000	33,000	1.1
s. l. and f. s. l.	20,000	6,000	20,000	20,000	66,000	2.2

Soil names	Crop A.	Pasture A.	Wooded A.	Urban, etc. A.	Total A.	%
Enfield						
v. f. s. l.	26,000	3,000	5,000	5,000	39,000	1.3
Merrimac, Hartford, etc.						
s. l. and l. s.	64,000	8,000	24,000	30,000	126,000	4.0
l. and f. s. l.	12,000	5,000	10,000	15,000	42,000	1.4
coarse sand	10,000	1,500	22,500	5,000	39,000	1.3
Suffield, etc.						
si. l. and cl. l.	15,000	12,000	6,000	6,000	39,000	1.3
Podunk, etc.						
l. and si. l.	17,000	19,000	18,000	6,000	60,000	2.0
Muck, etc.	3,000	12,000	82,000	2,000	99,000	3.3
Tidal marsh—18,000 A.	.....	.....	.....	.....	18,000	0.6
Rough stony land	.....	.....	90,000	.....	90,000	3.0
	656,000	477,000	1,703,000	236,000	3,090,000	100.0

A tabulation of the soils on 190 dairy farms in seven towns of the Eastern Highland indicates the relative importance of soils of the 16 series which were there identified, as shown in Table VIII. "Improved land" in this table includes cultivated crops, hay fields, open pasture and farmstead sites.

TABLE VIII. SOIL SERIES AND IMPROVED LAND DISTRIBUTION ON EASTERN CONNECTICUT DAIRY FARMS.

Series	Percentages: Of series in improved land	Of improved land in series	Of all farm land in series
Charlton	44.03	25.40	16.88
Gloucester	18.25	18.21	29.19
Merrimac	80.14	14.25	5.20
Taugwank	41.34	10.17	7.20
Coloma	45.41	9.08	5.85
Hinckley	23.30	8.39	10.54
Brookfield	26.81	7.31	7.98
Whitman	9.23	3.30	10.47
Peru	49.56	1.34	0.79
Plymouth	22.47	1.32	1.72
Podunk	67.19	0.41	0.18
Muck	3.49	0.30	2.52
Hinsdale	7.38	0.26	1.02
Ondowa	100.00	0.12	0.03
Sutton	100.00	0.09	0.03
Scarbro	100.00	0.05	0.02

The last three series are represented in such small areas as to be of no significance. For the other soils, the degree of improvement is nearly what one should expect from their stoniness, topography, and moisture conditions as affected by texture, organic content and the character of the substratum. Apparently a superior natural supply of plant nutrients is either not characteristic of any of these soils, or has little relationship to their selection for agricultural use.

PART III

A CRITICAL STUDY OF THE CHEMICAL COMPOSITION OF REPRESENTATIVE CONNECTICUT SOILS

Soil investigators of two or three decades ago hoped that it would be possible to determine the fertilizer requirements of soil through chemical analyses of soil samples, and many attempts were made to correlate such analytical results with field productivity. The results were disappointing in most instances, and a strong prejudice was built up against the use of chemical soil analyses as a guide in soil diagnosis.

However, the rapid developments in science during recent years have furnished many new tools for attacking the very complex problems of soil chemistry and its relationships with the nutritional requirements of crop plants. While we are yet far from a solution of many important questions, it is now believed that a detailed knowledge of the chemical soil characteristics is a definite aid to the intelligent use of fertilizers, lime and other soil amendments.

During the past five years a large number of representative samples of the important soil types of the state under various cropping systems has been under chemical investigation. The results of these studies are here briefly summarized and will be discussed under headings referring to the particular element or characteristic in question.

Organic Matter and Nitrogen

Organic matter and nitrogen are so closely related in agricultural soils that no permanent change in one can be effected without a corresponding change in the other.

The surface soils of this state, with the exception of forested soils, contain organic matter and total nitrogen in a fairly definite ratio. More than 100 soils for which both the nitrogen and organic matter (computed from total organic carbon) were determined, gave an average value of one part of nitrogen to 20 parts of organic matter, with fluctuations between the limits of 1:16 and 1:25. This is in agreement with the results of Sievers[1] on some typical Massachusetts soils. It thus follows that the total nitrogen content is a good measure of the organic content of the soil, and that a soil with 0.2 per cent of nitrogen contains approximately four per cent of organic matter.

In most cases results of chemical analyses of surface soils are here reported as pounds per acre on the basis of a conventional rule that an acre of soil to plow depth contains approximately 2,000,000 pounds of dry soil. Pounds per acre may be calculated to per cent by dividing by 20,000. Thus 4,000 pounds per acre represent 0.2 per cent of the dry weight of the soil.

[1] Sievers, F. J., Jour. Am. Soc. of Agron., 22: 10-13, 1930.

Table IX. Nitrogen Content of Connecticut Soils.

	No. of soils	Average: Total percentage	Average: Nitrogen content lbs. per A. of surface soil	Min. and max. range lbs. per A.
General crops and mowing				
Gloucester f. s. l. and loam	13	.243	4874	1990-9635
Brookfield f. s. l. and loam	8	.20605	4121	2486-5670
Charlton f. s. l. and loam	25	.23530	4706	2650-9850
Wethersfield f. s. l. and loam	8	.12260	2452	1590-3622
Dover f. s. l.	2	.12270	2454	1860-3048
Whitman loam	4	.31160	6232	5850-6950
Taugwank loam	5	.25410	5082	2740-7320
Merrimac f. s. l.	4	.12950	2590	1550-5126
Hinckley gravelly loam	3	.31010	6202	4240-8795
Hartford f. s. l.	3	.16780	3356	2420-3850
Suffield clay loam	2	.18175	3635	3290-3980
Podunk silt loam	25	.11600	2320	1200-3580
Weighted average		.24210	4842	1200-9850
Permanent pasture land				
Gloucester f. s. l. and loam	17	.20235	4047	2930-5362
Brookfield loam	2	.22875	4575	4340-4810
Charlton f. s. l. and loam	21	.26275	5255	3350-7366
Wethersfield f. s. l. and loam	6	.19550	3910	2580-6796
Becket f. s. l.	2	.27370	5475	5450-5500
Whitman loam	2	.34605	6921	6220-7622
Suffield clay loam	3	.14780	2956	2346-3516
Merrimac loamy sand	2	.07040	1408	1266-1550
Other soils	5	.21560	4312	2272-6674
Weighted average		.22295	4459	1266-7622
Tobacco land				
Merrimac f. s. l. and sandy loam	29	.14630	2926	2300-4100
Merrimac loamy sand	20	.13210	2642	1560-3100
Wethersfield loam	12	.15420	3084	2166-4170
Enfield v. f. s. l.	10	.13450	2690	2150-3575
Scarbro loam	8	.27650	5530	4966-6366
Weighted average	79	.15560	3112	1560-6366
Barren and other waste land				
Sand barrens of Wallingford and Windsor	4	.05060	1012	386-1545
Old field types	6	.1777	3554	2830-4416

There is a wide range in the nitrogen and consequently in the organic content of Connecticut soils, ranging from 386 to 9,635 pounds per acre of surface soil. (This does not include organic soils, such as muck, peat and tidal marsh.) The average for all soil types of the various cultural groups is approximately 0.2 per cent, equivalent to 4,000 pounds per acre of surface soil.

It is of interest to compare these figures with soils of other regions.

TABLE X. NITROGEN CONTENT OF OTHER SECTIONS OF EASTERN UNITED STATES.

	Percentage of nitrogen in surface soil
165 Coastal plain soils of N. C.	.039
71 Piedmont soils of N. C.	.048
381 Kentucky soils	.120
485 West Virginia soils	.150
125 Ohio soils	.187
105 New York soils	.207
30 Minnesota soils	.338

It is thus seen that the soils of Connecticut as a class compare quite favorably with those of other states and are much higher than those of states further southward.

In a comparison of cultural groups, soils in general crops and mowing, chiefly on dairy farms, contain the highest amounts of nitrogen (4,842 lbs. per acre). The pasture soils are somewhat lower (4,459 lbs.) while the tobacco soils chiefly of sandy texture and lying within the central lowland area of the states, are distinctly below the average (3,112 lbs.).

Of the various soil types within the respective cultural groups, the poorly drained soils, like the Whitman and Scarbro soils, are highest in nitrogen, with Charlton and Gloucester types above the general average, while the Wethersfield and Merrimac soils are definitely lower in nitrogen content. Beyond these generalizations, there is an insufficient number of soils of any one type to justify any definite conclusions.

It does not appear that soils of average texture have suffered any serious decline in nitrogen content in the 200 years or more of agricultural use. The nitrogen content of 21 forest soils to the depth of seven inches, and including any litter which may occur on the forest floor, gives an average of 0.205 per cent nitrogen, which is almost identical with the average of the agricultural soils. Certain excessively sandy soils have undoubtedly suffered some depletion in organic matter and nitrogen content as was found to be the case in a special study of the organic matter of tobacco soils.[1]

The humus and nitrogen requirements of Connecticut soils. The benefits derived from an adequate supply of organic matter are manifold. Excessively sandy soils are improved in moisture-holding and plant food-absorbing capacity. Heavy clay soils are made less difficult to cultivate. Micro-organisms require energy material from decomposing organic matter and plant food constituents, chiefly nitrogen, are liberated by its decomposition.

The present supply of organic matter is adequate to meet these

[1] Morgan, M. F., Conn. Agr. Exp. Sta., Tobacco Substa. Bull. 10:66-71. 1927.

requirements on most soils of the state, but this does not remove the necessity for the continued conservation of a favorable humus supply in every way possible, through green manure crops and animal manures on intensively cultivated lands, the plowing under of sods that have been properly thickened by adequate fertilization, and the return to the soil of plant residues. As manure becomes less abundant, it may become increasingly difficult to maintain a favorable supply of organic matter, but the prospects for serious depletion are not as serious as in many other regions.

The relatively good nitrogen supply which is stored up in most Connecticut soils is a potentially valuable reserve but it should not be depleted by a corresponding decrease in humus content of the soil. Some crops on soils which have been investigated in greenhouse fertilization experiments have shown little or no response to nitrogen under the favorable temperature and the absence of leaching which occur under such conditions. This is due to a liberation of soil nitrogen which is not comparable to field results. Non-leguminous crops demand that nitrogen be added to the soil in commercial fertilizers, manure or the growth of legumes, to offset the rapid loss of liberated soil nitrogen through leaching and crop removal. Available fertilizer of nitrogen during certain periods of crop growth is needed to supplement the supply that naturally becomes available during that time, or to replace losses through leaching.

Soils which contain a relatively low total nitrogen content, such as the Merrimac and Wethersfield types, especially under continuous tobacco culture or intensive vegetable cropping, are in a more serious need of large amounts of fertilizer nitrogen than the upland soils such as the Gloucester and Charlton types under dairy farming or pasture conditions.

The Total and Available Phosphorus Supply in Connecticut Soils

Phosphorus, an element very commonly deficient in soils of eastern United States, exists in the soil in relatively small quantities, and the total amount rarely exceeds 0.15 per cent of the dry weight of surface soils. With figures ranging downward to less than 0.05 per cent, there is a very limited reserve supply and a serious danger of depletion if losses through crop removal and grazing are not replaced by fertilization.

Phosphorus is a relatively insoluble constituent in soils and the water-soluble phosphorus that can be leached or extracted from soils is so small that there is practically no loss through leaching. However, some of the soil phosphorus is in combinations that become available for plant growth, even though it is not dissolved in the soil water. The determination of this available phosphorus

supply is a difficult chemical problem, and no completely satisfactory method for its measurement has been devised. However, our investigations have given a good general agreement between the amount of phosphorus which is dissolved from the soil by N/100 sulfuric acid (obtained by five minute digestion of 10 grams of soil with 100 cubic centimeters of the dilute acid solution) and the response of crops to phosphorus treatments under greenhouse conditions. The values here reported as "available" phosphorus were obtained by this method.

TABLE XI. THE TOTAL AND AVAILABLE PHOSPHORUS IN CONNECTICUT SOILS.

		Pounds per acre in surface soil			
		Total phosphorus		Available phosphorus	
	No. of soils	Average	Min. and max. range	Average	Min. and max. range
General crops and mowing					
Gloucester f. s. l. and loam ..	13	1817	1508-2404	8.5	2. —24.2
Charlton loam and f. s. l.	25	1996	1080-3638	9.14	2. —24.0
Wethersfield f. s. l.	8	1378	898-2168	16.57	2. —38.0
Brookfield loam	8	1975	970-3400	6.18	2. —23.0
Taugwank loam	5	1538	622-2440	2.70	1.8 — 5.0
Merrimac f. s. l.	4	2094	1660-2670	14.75	6. —23.0
Whitman loam	4	2055	1532-2588	2.43	1.9 — 3.0
Hartford sandy loam	3	1761	1218-2510	22.50	20. —25.
Dover f. s. l.	2	1690	1612-1768	30.5	30. —31.
Suffield clay loam	2	1331	1121-1540	7.5	5. —10.
Podunk silt loam	25	1756	648-2926	16.7	0.5 —36.
Weighted average		1819	622-3638	10.26	0.5 —38.
Pasture					
Gloucester f. s. l. and loam ..	17	1739	612-5150	3.67	2.0 — 8.25
Charlton loam and f. s. l.	21	1677	567-3260	3.91	1.25—12.00
Wethersfield f. s. l.	6	1901	1456-2430	4.62	2.4 — 6.2
Brookfield loam	2	2165	1448-2884	2.4	2.0 — 2.8
Beckel f. s. l.	2	977	844-1110	2.9	1.4 — 4.4
Whitman loam	2	1181	800-1562	3.05	2.9 — 3.2
Suffield clay loam	3	1227	1135-1360	3.55	2.25— 5.7
Merrimac loamy sand	2	1321	932-1710	10.5	6. —15.
Other soils	5	2275	1545-3700	4.55	2. — 8.
Weighted average		1709	612-5150	4.06	1.25—15.
Tobacco land					
Merrimac sandy loam	12	2890	1376-4080	39.72	16.5 —60.
Enfield v. f. s. l.	3	3480	2530-4430	45.0	28. —62.
Other soils, unclassified	48	3260	1750-4960	44.0	25. —63.
Weighted average		3200	1376-4960	42.5	16.5 —63.
Barren and other waste land					
Sand barrens of Wallingford and Windsor	4	842	502-1284	6.25	3. —11.
Old field types	6	1513	980-2220	5.3	1. —13.4

With respect to phosphorus, both total and available, the soils of he state are also extremely variable, the total amount ranging from 02 to 5,150 pounds per acre, while the "available" phosphorus as neasured by laboratory tests ranges from 1 to 63 pounds. The

average for the state is 1,838 pounds of total phosphorus, equivalent to 0.0919 per cent in the surface soil, and an availability test of 9.84 pounds per acre.

Results of the availability tests used at this station are not directly comparable to those reported from other states, but the following table gives a fair comparison of the conditions of total phosphorus supply.

TABLE XII. TOTAL PHOSPHORUS CONTENT OF SOILS IN OTHER STATES.

	Total phosphorus in surface soil, percent
Kentucky "Bluegrass" soils	0.470
West Virginia, 485 soils	0.052
Illinois, light colored prairie soils	0.060
Illinois, heavy black prairie soils	0.100
Ohio, 126 soils	0.056
New York, average loam	0.074
New Jersey, 14 soils similar to Conn. types	0.073

The total phosphorus content of Connecticut soils is at least as good as, if not above the average of soils in other states, with the exception of the "bluegrass" region of Kentucky and the highly fertile black prairie soils.

In a comparison of cultural groups, soils in tobacco for a period of years are very significantly higher than the other soils of the state. This has been explained in a previous publication[1] on the basis of phosphorus accumulation from heavy fertilization in excess of crop requirements. There is little significant difference between the total phosphorus content of general crop lands and pasture although the average is slightly lower for the latter group.

As between soil types, there appears to be no consistent difference, with the exception of the very infertile barren sand areas in Wallingford and Windsor.

The phosphorus requirements of Connecticut soils. Although the total amounts of phosphorus in most Connecticut soils do not indicate a serious depletion, the availability of the native soil phosphorus is very low in all soils that have not been so heavily fertilized as to produce a surplus of the more available phosphorus in fertilizer residues. This condition has been definitely proven, both by laboratory tests and by fertilizer experiments in both greenhouse and field. The pasture areas, which have rarely received any fertilizer in return for the removal of available phosphorus in animal growth and milk production, are in the most serious condition in this respect. The average of 60 typical pasture soils of the state shows a phosphorus test of only about four pounds per acre,

[1] Anderson, P. J., Morgan, M. F., and Nelson, N. T., Conn. Agr. Exp Sta., Tobacco Substa. Bull. 7. 1927.

as compared to 10 pounds for the general crop and mowing land soils of the state and the very high average of 42.5 pounds for the heavily fertilized tobacco soils. This confirms the results of the Storrs pasture experiment[1] and the numerous pasture fertilizer trials conducted by the Extension Division of the Connecticut Agricultural College.

The general crop and mowing lands, while less seriously depleted in available phosphorus than the pasture lands, are still very seriously in need of fertilizer phosphorus in most cases. The results of the analyses reported in Table XI and of greenhouse results, shown in Tables XXII, XXV, XXIX and XXXII, are supplemented by an extensive survey of phosphorus availability on the fields of a large number of dairy farms in southeastern Connecticut. Of more than 300 fields in the towns of Stonington, North Stonington and Griswold, 87.4 per cent showed tests of 10 pounds or less of phosphorus per acre, and on all such fields we should reasonably expect a marked response to fertilizer phosphorus for almost any crop.

The conditions on all land that has been under heavy tobacco fertilization for a number of years have justified a recommendation of a practical decrease in the rate of application of "phosphoric acid" from the 160 to 200 pounds per acre which has been common in recent years, to as low as 100 pounds per acre. On new tobacco land not previously so heavily fertilized, the higher amounts should be continued for at least the first few years, until a substantial reserve has accumulated. The failure of old tobacco fields, such as the Tobacco Substation field at Windsor, to show significant response to phosphorus fertilization is not due to the low phosphorus requirements of the crop, since tobacco is extremely sensitive to a lack of adequate amounts of available phosphorus in the soil.

A similar condition probably exists on lands that have been very heavily fertilized for potatoes and vegetable crops, and in many such cases the common use of amounts in excess of 100 pounds per acre of "phosphoric acid" in the fertilizer may not be justified.

Total and Replaceable Potassium Supply of Connecticut Soils

Potassium (indicated in fertilizer formulae under the term "potash") exists in most soils in relatively large amounts as compared to nitrogen and phosphorus. On the other hand, most of the total potassium content of the soil is of a very insoluble character, existing in the form of the complex alumino-silicates of rock minerals. In a much more available form, a small part of the total potassium content of the soil occurs in the so-called "replace-

[1] Brown, B. A., and Slate, W. L., Storrs Agr. Exp. Sta. Bull. 155. 1929.

able" or "exchange" condition, being absorbed by the colloidal material of the soil, from which it may be liberated by washing the soil repeatedly by solutions of neutral salts or of dilute acids.

Measurements of available potassium in the soil by chemical means are very difficult. Very little exists in water-soluble form, on account of the absorbing power of the finer particles of the soil for this element. With soils of similar physical character, differences in amounts of "replaceable" potassium are usually associated with differences in "potash" availability.

TABLE XIII. THE TOTAL POTASSIUM CONTENT OF CONNECTICUT SURFACE SOILS.

	No. of soils	Average Percent	Average Lbs. per A.	Min. and max. range—lbs. per A.
General crops and mowing				
Charlton loam and f. s. l.	25	1.4260	28,952	15,791-44,760
Gloucester f. s. l.	13	1.1717	23,435	11,244-31,292
Brookfield loam and f. s. l.	7	1.5557	31,114	16,980-42,483
Wethersfield f. s. l. and l.	6	1.4154	28,108	21,760-31,924
Taugwank loam	3	1.2512	25.024	16,659-35,678
Merrimac f. s. l.	4	1.7090	34,180	20,028-47,032
Suffield clay loam	2	2.5743	51,487	50,877-52,098
Podunk silt loam	25	2.0060	40,120	29,720-57,640
Other soils, unclassified	7	1.2957	25,914	16,723-35,700
Weighted average		1.4273	28,546	11,244-57,640
Permanent pasture land				
Charlton loam and f. s. l.	21	1.5853	31,707	21,700-43,920
Gloucester f. s. l.	16	1.4973	29,946	17,109-43,856
Wethersfield f. s. l. and l.	6	1.4194	28,388	19,425-35,280
Merrimac loamy sand	2	0.8989	17,979	17,660-18,299
Suffield clay loam	2	2.3235	46,471	42,901-50,041
Whitman loam	2	1.1827	23,653	23,509-23,798
Other soils, unclassified	8	1.5862	31,724	21,193-43,770
Weighted average		1.5300	30,600	17,109-50,041
Tobacco land				
Merrimac sandy loam	5	1.2013	24,027	13,720-28,658
Enfield v. f. s. l.	2	1.3218	26,436	....
Average	7	1.2215	24,430	13,720-28,658
Sand barrens and waste land	8	1.3710	27,420	19,104-40,944

Although the total potassium content of Connecticut soils shows considerable variation, the proportionate range is not as great as for the other chemical constituents previously discussed. The state average of approximately 29,000 pounds per 2,000,000 pounds of surface soil, is similar to the potassium content of soils of similar texture in other parts of the country.

There appears to be a general correlation between the texture of the soil and the total potassium content. The lighter textured sandy loam soils of the tobacco district are lower, as a class, while the heavier podunk silt loam and Suffield clay loam are higher in potassium. However, there are individual fields of loam and fine sandy loam texture that are lower than some of the most barren

areas of sand. A large proportion of the sand grains of the sandy soils of this state are composed of minerals that contain potassium (such as fragments of muscovite mica and orthoclase feldspar). This is not so commonly true of the sandy soils of other regions, particularly of the Atlantic coastal plain, where the larger sand grains are chiefly of quartz.

The potassium requirements of Connecticut soils. In spite of their high amounts of total potassium, the soils of this state that have not been liberally fertilized or manured are commonly so deficient in available potassium that most crops grown upon them are apt to suffer from a deficiency in this element. This condition is suggested by the results of "replaceable" potassium determinations reported in Table XIV and confirmed by the results of greenhouse and field trials, Tables XXIII, XXVI, XXX and XXXII.

TABLE XIV. REPLACEABLE POTASSIUM IN SOME CONNECTICUT SOILS.

	Replaceable potassium		
	Average		Min. and max. range
	Percent	Lbs. per A.	lbs. per A.
General crops and mowing, 33 soils from 12 soil types	.00684	136.80	51.46- 474.36
Pasture land, 14 soils from 8 soil types	.00620	124.40	33.72- 239.50
Tobacco, 7 soils	.02356	471.20	133.46-1961.76

The number of soils of any particular soil type was not sufficient to justify any classification on this basis, and there did not appear to be any consistent correlation for any soil type.

However, the effects of previous heavy fertilization are noticeable in case of the soils from tobacco land, which as a class have the lowest total potassium content because of their sandy texture, while their replaceable potassium is much higher than in soils from pasture land and general crops. On the other hand, tobacco fertilization that provides very liberal amounts of potash is justified on the basis of the high potassium requirements of this crop and the considerable leaching losses of potassium from such soils.

Since most vegetables and potatoes are quite sensitive to deficiencies in potash availability in the soil, fertilizers for such crops practically disregard the reserve of this element in the soil. With liberal applications of manure, the use of more than 80 pounds per acre of fertilizer potash for these crops should be adequate, while on sandy soils and with little or no manure as much as 150 pounds per acre may be profitable.

Corn and grass hay on dairy farms may not suffer from lack of potash if the land is well manured, but the results of pot experiments on soils from such fields, reported later, provide strong arguments in favor of the more general use of fertilizer potash. Alfalfa may be expected to respond to "potash" on most soils, and the use

of from 100 to 125 pounds of potash per acre on land that is to be seeded to alfalfa is an insurance against a strong possibility of deficiency in this respect.

The potassium situation on permanent pasturelands of the state is still a rather open question. The Storrs pasture experiment has shown little response to potash fertilization, and in general it is believed that until adequate amounts of limestone and superphosphate have been used, the pasture soils will not respond to this element. A high level of productivity of pasture herbage may not be possible on many soils until potash is also used.

Calcium and Magnesium Content of Connecticut Soils

With the exception of a few small areas of the Dover series in western Connecticut, the soils of the state contain calcium and magnesium that is not derived from the decomposition of limestone, but is liberated from the slow weathering of complex silicates such as soda-lime feldspar and ferro-magnesian minerals. Thus, although the soils are predominantly acid, there may be a fair amount of total calcium and magnesium in the soil composition.

TABLE XV. TOTAL CALCIUM AND MAGNESIUM OF CONTENT OF CONNECTICUT SOILS.

		Pounds per acre of surface soil			
		Calcium		Magnesium	
	No. of soils	Average	Max. and min. range	Average	Max. and min. range
General crops and mowing					
Charlton	16	20,495	11,840-36,800	11,654	5,951-26,100
Gloucester	10	22,759	13,680-26,683	10,182	6,405-13,671
Brookfield	5	23,057	9,902-36,960	16,889	4,886-31,446
Wethersfield	4	11,505	10,720-12,160	8,453	5,450-12,480
Taugwank	3	24,327	18,240-30,262	9,669	6,640-14,195
Other soils	6	24,070	12,160-34,818	17,845	4,824-32,572
Average	44	21,232	9,902-36,960	12,332	4,824-32,572
Pasture land					
Average	11	20,487	10,760-44,740	10,431	4,196-18,760
Tobacco land					
Merrimac sandy loam	5	14,736	11,540-20,160	6,127	4,760- 7,200
Enfield v. f. s. l.	2	17,570	17,440-17,700	8,360	6,859- 9,860
Sandy barrens and other waste land	..	12,947	10,000-15,260	7,177	5,420- 8,340

The average calcium content is 19,827 pounds and the magnesium content 11,140 pounds, per 2,000,000 pounds of surface soil. The variation is considerable, especially in the magnesium content.

The chief difference in cultural groups is the consistently lower figures of both calcium and magnesium for the soils of the tobacco district. (These do not include any samples of soil from the

Housatonic Valley tobacco section, where the opposite conditions may occur.) Many tobacco soils do not naturally contain sufficient available calcium and magnesium for best quality of the cigar ash, and the tobacco plants on some of the sandier soils show actual magnesium deficiency symptoms.

It is doubtful if calcium is ever an actual limiting factor in crop yields on Connecticut soils. Except in the case of tobacco, lack of available magnesium is not known to be a cause of poor yield in this state. However, Jones[1] has found a type of chlorosis in corn which is associated with magnesium-hunger on a soil at the Massachusetts Agricultural Experiment Station.

On the other hand, the "replaceable" calcium in soils is often rather low, especially on highly acid soils. In such cases the absorptive capacity of the soil for bases ("base exchange capacity") is not fully satisfied, and since calcium represents approximately 80 per cent of the exchangeable bases, a base-unsaturated acid soil would show a low value for replaceable calcium.

This is evidenced in the following table.

TABLE XVI. REPLACEABLE CALCIUM AND pH OF CERTAIN CONNECTICUT SOILS.

Replaceable Calcium in Pounds per 2,000,000 of Surface Soil.

Group	Average	pH Average	No. of soils
0— 499	302.68	4.87	13
500— 999	717.03	5.00	20
1000—1999	1408.00	5.12	18
2000+	2792.00	5.84	6

There were no evidences of correlation between replaceable calcium and either soil type or cultural class. There were wide variations in soil acidity, as expressed in pH, for soils of similar replaceable calcium content, but there was a general trend toward high acidity with low replaceable calcium.

The Acidity of Connecticut Soils

Most soils of this state are naturally acid, and except for certain areas of the Dover series where limestone outcrops lie near the surface, soils that have not received lime or limestone applications are almost certainly acid. The conditions of Connecticut soils with respect to acidity and lime requirement have been extensively studied. A previous publication[2] summarizes tests of more than 2,000 tobacco fields in the Connecticut Valley. Nearly 1,500 fields in general farm crops and mowing, distributed over 190

[1] Jones, J. P., Jour. Agr. Res. 39: 873-892. 1929.
[2] Morgan, M. F., Conn. Agr. Exp. Sta. Bul. 306. 1929.

farms in the towns of Griswold, Woodstock, Coventry, Brooklyn, Columbia, Stonington, North Stonington and Canterbury, have been examined for soil acidity. These results are supplemented by the results of tests of the soils that have been analyzed for all important constituents in this laboratory, besides those of more than 500 soils that have been sent in by farmers and gardeners during the past five years.

It is obviously unnecessary to present the individual results of all these tests, and the large number of samples for which we have record justifies the following conclusions:

1. With the exception of soils closely related to limestone outcrops in certain parts of western Connecticut, indicated as the "Dover" soil area on the accompanying soil map, there is no relationship between soil type and soil acidity. In other words, no one soil type is naturally more acid than another.

2. For equal degrees of acidity as measured by the pH test, there is a correlation between lime requirement and the textural and organic characteristics of the soil. Sandier soils at the same pH require less lime to correct the acidity than more loamy or clayey soils, while soils with much organic matter require more lime than those with a lower organic content. This is fully discussed from a technical viewpoint in a journal paper.[1]

3. The previous cultural history is the chief factor in determining the present degree of acidity of the soil. As a group, the pasture soils are slightly more acid, with an average of 4.91 pH. Until the past few years lime was never applied to permanent pasture land, and as yet few such areas have been limed.

Little difference exists between the average figures for tobacco soils (5.37 pH) and for the fields in general crops and mowing (5.39 pH), although the latter group includes 13.4 per cent which have been limed to reaction of above 6.2 pH, and on the tobacco soils only about four per cent of the fields lie above this limit. Tobacco farmers have rightly avoided the use of heavy lime applications, which favor the black root rot organism.

Gardens and fields used for vegetable crops have usually been limed heavily, and are rarely found to be strongly acid.

The lime requirements of Connecticut soils. The amount of lime that should be used on any particular field is determined by four factors:

1. The acidity of the soil, such as measured by pH tests.
2. The textural character of the soil.
3. The organic content of the soil.
4. The optimum reaction for the crop to be grown.

The relationship between the acidity of the soil and its lime requirement as affected by texture and organic content is indicated by the following table:

[1] Morgan, M. F., Soil Sci., 29: 163-180. 1930.

TABLE XVII. LIMESTONE ($CaCO_3$) REQUIRED TO NEUTRALIZE SOIL ACIDITY UNDER AVERAGE CONNECTICUT CONDITIONS (IN TONS PER ACRE).

Soils testing between following pH limits	Very sandy soils Low O.M.[1]	Very sandy soils Medium O.M.	Sandy loams Low O.M.	Sandy loams Medium O.M.	Loams and fine sandy loams Low O.M.	Loams and fine sandy loams Medium O.M.	Loams and fine sandy loams High O.M.
3.80-4.19	1.50	2.25	2.55	3.15	3.50	4.40	5.35
4.20-4.59	1.30	1.95	2.21	2.73	3.00	3.80	4.65
4.60-4.99	1.10	1.65	1.87	2.31	2.50	3.20	3.95
5.00-5.39	0.90	1.35	1.53	1.89	2.25	2.70	3.25
5.40-5.79	0.70	1.05	1.19	1.47	1.75	2.10	2.55
5.80-6.19	0.50	0.75	0.85	1.05	1.25	1.50	1.75
6.20-6.59	0.30	0.45	0.51	0.63	0.75	0.90	1.05
6.60-6.99	0.10	0.15	0.17	0.21	0.25	0.30	0.35

A discussion of the specific reaction preferences and crop lime requirements is not within the scope of this bulletin. However, the following general statements indicate the situation of the state as a whole with respect to the need for lime in growing the economically important crops.

1. About 15 per cent of the improved land of the state is so acid that all crops grown are a practical failure because of the high acidity of the soil.
2. Sixty per cent of the Connecticut fields are so acid that corn and grass hay would probably be benefited by liming.
3. Seventy-five per cent of the land does not grow clover well on account of lime needs.
4. Alfalfa and acid sensitive vegetable crops could not be grown on 90 per cent of Connecticut soils without liberal lime applications.
5. Only one per cent of the total improved area of the state is now limed to the point where no soil acidity exists.
6. Practically all permanent pasture lands must be limed as the first step in pasture improvement before superphosphate and other fertilizers can produce a material benefit.
7. About 70 per cent of fields used for tobacco are at a favorable soil reaction for that crop. About 20 per cent of these soils are so acid that moderate lime applications should be beneficial, while ten per cent have been too heavily limed in the past, with serious black root rot troubles as a consequence. Light applications of magnesian lime might improve the quality on most of the balance of the area.
8. Lime has usually been liberally used on fields devoted chiefly to vegetable crops and the main use of lime in this type of farming will be for maintaining these fields at the present favorable reaction and for new fields not previously limed.

Aluminum and Manganese as Soil Toxins in Acid Soils

Under the strongly acid conditions such as have been shown to exist over much of the state, aluminum and manganese tend to form soluble compounds in the soil. It has been shown clearly at the Rhode Island Agricultural Experiment Station that the high concentration of soluble aluminum which exists in certain strongly

[1] O.M. stands for organic matter in above table, where
—low O.M. is indicated by light brown, yellowish-brown or reddish-brown color.
—medium O.M. is indicated by medium brown or gray brown color.
—high O.M. is indicated by dark brown or very dark grayish brown color.

acid soils of that state is quite poisonous to many crops, while soluble manganese is similarly injurious to some species of plants.

Connecticut soils frequently show considerable amounts of aluminum compounds which are soluble in N/2 acetic acid (so-called "active" aluminum). Twenty-five acid soils when studied under greenhouse conditions showed amounts of "active" aluminum ranging from 571.5 to 69 p.p.m. (parts per million) of Al (equivalent to from 1,080 to 130.4 p.p.m. of Al_2O_3) on soils ranging in acidity from 3.94 to 5.26 pH. Within this group of soils, six soils, testing above 4.8 pH, averaged 120.23 p.p.m. "active" Al, while nine soils testing below 4.2 pH averaged 336.6 p.p.m.

The amounts of water-soluble aluminum present in the soil are small but under strongly acid conditions can be readily detected. Water extracts from soils above 5 pH rarely give a positive test for aluminum, while at lower pH values, tests of leachates from the soil range from about 1 p.p.m., up to about 40 p.p.m., the higher values usually being found on the more acid soils.

Active manganese has also been determined by the half-normal acetic acid method for a number of Connecticut soils. Forty soils ranging from 3.94 to 6.0 pH gave "active" manganese (Mn) of from 0 to 409.0 p.p.m. A correlation between degree of acidity and "active" manganese is suggested in the following table.

TABLE XVIII. "ACTIVE" MANGANESE AND SOIL ACIDITY.

pH group	No. of soils	Average "active" Mn p.p.m.	Range
3.90—4.19	9	113.78	26.6—409.
4.2— 4.79	6	45.40	11.5—116.4
4.8— 5.20	8	21.80	6.0— 46.1
Above 5.20	7	3.16	0.0— 4.2

Manganese is present in the water extracts or leachates from strongly acid soils in appreciable concentrations. This is indicated by some preliminary data from the lysimeter at Windsor, and from analyses of leachates from greenhouse soil pots of different soils and treatments. Thus in a greenhouse experiment with tobacco, two and a half liters leached through 8,000 grams (dry weight) of a soil testing 4.5 pH, with tobacco showing marked symptoms of manganese toxicity, gave a concentration of 47.3 p.p.m. of manganese. The maximum thus far obtained in leachates from acid soils has been 70.5 p.p.m. Details of these studies on water-soluble manganese will be published later.

It is thus seen that Connecticut soils of strong acidity (below 5.0 pH) may contain sufficient amounts of both aluminum and manganese in forms that may be toxic to the growth of plants that are sensitive to soluble concentrations of either of these elements. It has been shown that tobacco is definitely injured by manganese poisoning through the soil, although this particular crop appears not to be affected by the soluble aluminum concentrations that normally exist in acid soils.

PART IV

NUTRIENT REQUIREMENTS OF CONNECTICUT SOILS AS MEASURED BY VARIOUS CROPS IN GREENHOUSE AND SOIL FRAME EXPERIMENTS

Beginning in a small way with limited facilities in 1924 and 1925, and as an important phase of the work since the construction of a new greenhouse in 1926, pot experiments have been conducted to study the fertilizer and lime needs of the important types of Connecticut soils. During this period 79 different soils have been under investigation. The various soil types and the kinds of fields from which the samples were taken are shown in Table XIX.

TABLE XIX. CHECK LIST OF SOILS USED IN GREENHOUSE POT TESTS.

	Laboratory serial numbers				
Soil type	General crops and mowing, plowed within last five years	Old mowing lots	Permanent pasture	Tobacco	Waste land
ucester fine sandy loam	4, 10, 315	7, 22, 320	228, 317, 335	....	1
ucester loam	316, 318, 319	......	......	....	....
loma very fine sandy loam	......	......	322	....	....
ookfield fine sandy loam	17	......	......	....	....
nsdale fine sandy loam	......	236	......	....	....
lton fine sandy loam	229, 234	......	......	....	....
llis silt loam	......	234	......	....	....
ver fine sandy loam	14, 232	......	......	....	....
lyoke loam	......	......	235	....	....
ddletown loam	......	......	60	....	....
odbridge fine sandy loam	2, 15	5	225	....	....
arlton fine sandy loam	8, 11, 311, 312	241	......	....	....
arlton loam	3, 9, 12, 310	23, 313, 314	327, 340	....	....
gwank loam	234	237	......	....	....
ddam fine sandy loam	......	238	......	....	....
nox fine sandy loam	......	230	......	....	....
eshire sandy loam	......	......	......	....	344
eshire fine sandy loam	......	......	338	....	243
thersfield fine sandy loam	58	......	......	....	....
thersfield loam	20, 227	......	......	....	....
chfield loam	......	6, 16, 239	......	....	....
ket fine sandy loam	......	......	1	....	....
itman loam	......	240	......	....	....
ckley gravelly sandy loam	......	......	242	....	....
ckley fine sandy loam	......	......	241	....	....
ckley loam	321	......	......	....	....
nchester fine sandy loam	......	......	336	....	....
rrimac coarse sand	......	......	......	....	19
rrimac loamy sand	......	......	224	223	21
rrimac sandy loam	......	......	......	244	....
tford coarse sand	......	......	......	....	343
ield very fine sandy loam	......	......	246	....	....
field clay loam	......	18, 245	337	....	....
lunk silt loam	......	325	......	....	....
lunk loamy sand	......	......	......	....	326

The geographical distribution of these soils is shown in Figure 63.

The soils are collected in the field during the autumn months. About 500 pounds of the soil at normal field moisture content are thoroughly mixed, passed through a one-quarter inch screen to remove the coarse gravel and stone, bagged and brought into the laboratory, where it is air-dried and potted in two-gallon glazed earthenware pots with a hole for drainage and aeration at the

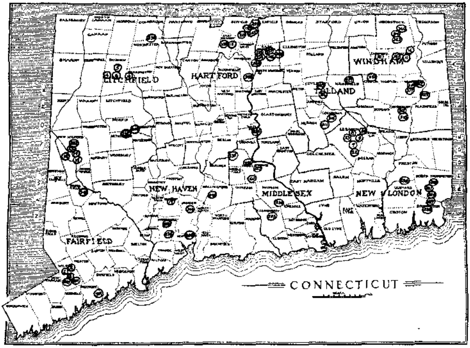

FIGURE 63. Locations of fields from which soils have been taken for fertilizer experiments in greenhouse plots and soil frames. The laboratory record numbers are indicated within the small circles.

bottom of the side. Lime in the form of precipitated chalk ($CaCO_3$) is added in amounts representing one and one-half the lime requirement as determined by the Jones laboratory method. The nutrient elements are applied in solution. The usual treatments per two gallon pot are as follows:

Nitrogen (N): 0.8 gm. urea.

Phosphorus (P): 1 gm. H_3PO_4 (85%).

Potassium (K): 1.5 gms. Potassium acetate.

Thus no other nutrient elements than N, P, and K are added in the fertilizer.

After applying the treatments the soils are made up to about 60 per cent water saturation, and seeded or planted about one week after the nutrient solutions are added.

Distilled water was used in 1924 and 1925, but as insufficient

amounts were available for the expanded greenhouse facilities in 1926, rain water collected from the laboratory roof was used for a time. This proved to be unsatisfactory because of its sulfur content and acid reaction, especially during the winter period when the nearby heating plant, buruing soft coal, was in operation. The tap water from the city mains was found to contain only negligible quantities of any of the nutrient elements, and it has been used exclusively for watering the pots during the past three years.

It was originally expected that the unlimed soils would remain at practically the same reaction as when collected from the field. However, subsequent pH tests of the variously treated soils showed an increase in the acidity of unlimed soils when kept under greenhouse conditions without being subject to leaching or the periodic return of low-temperature conditions such as naturally occurs in the field.

This tendency toward increased acidity is most noticeable with the nitrogen treatments (in the form of urea). This is in agreement with results with urea previously reported by Swanback and Morgan.[1]

An illustration of this trend toward increasing acidity in pot experiments is indicated in the data for soils 310 to 325 in 1929.

TABLE XX. SOIL REACTION OF SOILS 310 TO 325 IN GREENHOUSE POTS, NOVEMBER 13, 1929.

Treatments	310 pH	311 pH	312 pH	313 pH	314 pH	315 pH
NK	4.02	4.81	4.07	4.10	4.46	4.54
NP	4.01	4.28	3.94	4.14	4.13	4.11
PK	5.26	5.50	4.78	4.80	4.96	5.12
NPK	4.60	5.03	4.43	4.31	4.66	4.45
Soil from field in autumn, 1928	5.04	5.36	4.79	4.92	5.17	5.27

	316 pH	317 pH	318 pH	319 pH	320 pH
NK	4.66	4.10	3.83	4.06	4.79
NP	4.10	3.91	3.76	4.00	4.32
PK	5.26	5.09	4.27	4.85	5.15
NPK	4.65	4.21	3.93	4.22	4.90
Soil from field in autumn, 1928	5.23	5.18	4.72	4.91	5.36

	321 pH	322 pH	323 pH	324 pH	325 pH
NK	4.20	4.91	4.90	4.23	4.03
NP	3.92	4.08	4.63	4.15	3.93
PK	4.86	5.57	5.50	5.34	4.80
NPK	4.20	4.95	5.23	4.31	4.11
Soil from field in autumn, 1928	4.73	5.24	5.36	4.93	5.06

[1] Swanback, T. R., and Morgan, M. F., Conn. Agr. Exp. Sta. Bull. 311: 264-268. 1930

The increased acidity under the conditions of our pot experiments is apparently most marked in cases where nitrogen is added and either phosphorus or potassium is omitted from the treatment. The decreased plant growth, with a corresponding diminution of the removal of the soluble salts either added in the fertilizer or produced from the nitrification of the area, may explain this phenomenon.

At any rate, the results from lime treatments in these pot experiments must be interpreted on the basis of the reaction of the potted soil at the time when the crop is grown, rather than the original reaction of the soil when it was collected in the field. This has involved the periodic testing of the pH of the soil from each pot.

Alfalfa

Alfalfa was grown as a test crop on 48 of the soils listed in Table XIX. On only 14 of the soils (Nos. 233-246 inclusive) were the treatments so designed as to show response to nitrogen, since it was believed that this crop, being a legume, would show little or no response to that element. Under greenhouse conditions this proved to be the case, since soils 233 to 246 averaged 98 per cent yield with LPK as compared with 100 per cent on the LNPK and only two soils, Nos. 243 and 246, gave significant responses to nitrogen.

Lime. This was the most serious limiting factor on most of the soils, with an average yield of only 57 per cent without lime, as compared with 100 per cent where lime was applied.

The soils with reference to their response to lime may be grouped as follows, the reaction of the soil in the unlimed, fertilized pots being indicated:

TABLE XXI. GROWTH OF ALFALFA WITHOUT LIME ON COMPLETELY FERTILIZED SOILS AND THEIR REACTION.

Complete failure (less than 5% crop)		Practical failure 5-50% crop		Serious decrease in growth 50-90% crop				Little or no response to lime (90% crop or better)	
Soil No.	pH	Soil No.	pH	Soil No.	pH	Soil No.	pH	Soil No.	pH
234	3.92	2	4.76	1	5.11	19	4.94	3	6.26
237	3.88	224	4.81	5	4.94	20	5.51	3	5.98
239	4.25	225	4.65	6	5.11	21	5.52	10	6.58
243	3.78	228	4.67	7	4.92	22	5.44	14	7.08
		231	4.38	8	5.27	23	5.12	232	6.85
		233	4.76	9	4.96	24	5.14		
		238	4.33	11	5.48	223	5.86		
		241	4.53	12	5.53	226	5.41		
		244	4.59	13	5.07	227	5.35		
		245	4.72	15	5.32	229	5.30		
		246	4.46	16	5.34	230	5.42		
				17	5.51	235	4.74		
				18	4.81	236	4.78		

From the above data, it appears that there is a good general agreement between the lime needs of alfalfa on Connecticut soils and their pH values. At reactions below 4.4 pH, alfalfa is a complete failure, and less than half the yield capacity of the fertilized soils can be attained on soils more acid than 5 pH, with few exceptions. Definite responses to lime are obtained on all soils below 5 pH.

Phosphorus. The omission of this element from the fertilizer produced significant decreases in yield on both limed and unlimed soils in the majority of cases. The average for the 48 soils was an 81 per cent crop of alfalfa on the LK or LNK treatment.

There was no correlation between the total phosphorus content of the soil and its ability to produce a normal crop of alfalfa without phosphorus fertilization. There was a good general agreement between the "available phosphorus" as measured by the previously described laboratory method, and the yield capacity of the soil without the addition of phosphatic fertilizer. This is presented in Table XXII.

TABLE XXII. GROWTH OF ALFALFA WITHOUT PHOSPHORUS FERTILIZATION. (Available Phosphorus, in Pounds per 2,000,000 Pounds, Indicated After Serial Number of Soil.)

Practical failure (less than 50% crop)	Serious reduction in growth (50-90% crop)		Little or no response to phosphorus (90% crop or better)	
1-2	2- 5	224-15	3-33	21-10
6-2	7- 8	226-20	4-14	223-57
225-2	8- 6	227-12	5-10	229- 6
235-2	9- 5	228- 7	12-15	230-10
236-3	10-10	231- 7	13-23	232-42
240-2	11- 7	233- 2	14-31	238-10
	16- 8	234- 3	15-19	239-12
	17- 6	237- 2	18-10	244-40
	19- 7	241- 2	20-24	245-12
	22- 7	242- 2		
	23- 3	243- 5		
	24- 6	246- 7		

Potassium (Potash). The omission of potassium from the fertilizer is almost as serious as is the case with phosphorus, as shown by the results on these 48 soils, which produced on the average an 84 per cent crop on the LP or LNP treatments.

Here, also, there was no similarity between the total content of the element in the soil and the results when that element is omitted from the fertilizer. There is very little agreement between crop results and "exchange potassium" as determined in the laboratory.

TABLE XXIII. GROWTH OF ALFALFA WITHOUT POTASSIUM FERTILIZATION AND THE "EXCHANGE" POTASSIUM IN THE SOIL.

("Exchange" Potassium, in Pounds per 2,000,000 Pounds, Indicated After Serial Number of Soil Whenever Data Is Available.)

Practical failure (less than 50% crop)	Serious reduction in growth (50-90% crop)		Little or no response to potassium (90% crop or more)	
234- 75*	1-	232- 74*	2-	18-
236-148*	3-	233-155*	7-	20-
237-135*	4-	235- 90	9-	21-
243-182*	5-	238- 85	10-	22-
244-132*	6-	239- 72*	11-	24-
	8-	240- 51	12-	223- 64
	19-	241- 92*	13-	226-111*
	23-	242- 56*	14-	227-116
	224- 34*	245-131*	15-	229-214
	225-116*	246- 77*	16-	230-116
	228-166*		17-	231-240

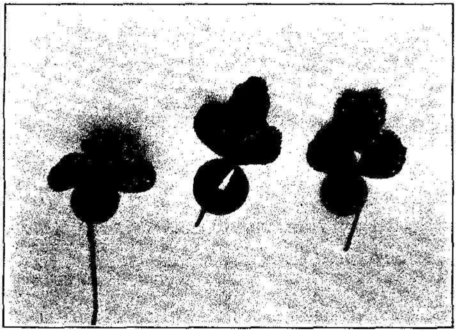

FIGURE 64. Characteristic alfalfa leaves showing spots typical of potash-hunger when grown in the LP pots of many Connecticut soils.

Soils 1 to 24 inclusive were fertilized with di-sodium phosphate as a source of phosphorus. The LP pots of these soils did not show the potash-starvation symptoms indicated by the characteristic spotting of the leaf pictured in Figure 64. This may have been due to a partial replacement of sodium for potassium in the physiological processes of the plant. All the other soils received

* Characteristic leaf spotting symptom when potassium was omitted.

no sodium in the fertilizer, and the leaf spotting was observed on many of the pots that received no potassium in the treatment.

A careful study of the data revealed no consistent correlation between fertilizer and lime requirements and the soil type, except for the lack of lime response on the limestone-derived Dover soils (Nos. 14 and 232).

Buckwheat

Buckwheat was grown in 1924 on soils 13 to 24 inclusive. It was not sufficiently sensitive to lime and nutrient deficiencies to produce significant yield differences on most of these soils, hence its use as an indicator plant to show soil deficiencies was discontinued, and the yield data is not here presented.

Lettuce

Lettuce, of the Cos or Romaine type, was grown as a test crop on 40 different soils. It proved to be a fairly satisfactory crop for indicating the lime and nutrient requirements of Connecticut soils. Yields on duplicate pots were frequently somewhat irregular, due to the failure of one or more plants to survive, but yield differences between various treatments were usually very great.

Lime. Lime was the most serious limiting factor. The crop was a total or practical failure on the majority of the soils when lime was omitted. The 40 soils produced an average of only a 28 per cent crop on NPK treatments. The results are summarized in Table XXIV.

TABLE XXIV. GROWTH OF LETTUCE WITHOUT LIME ON COMPLETELY FERTILIZED SOILS AND THEIR REACTION.

Total failure (less than 5% crop)				Practical failure (5-50% crop)		Serious lime deficiency indicated (50-90% crop)	
Soil No.	pH	Soil No.	pH	Soil No.	pH	Soil No.	pH
223	4.48	314	4.66	1	5.11	3	6.26
224	3.97	315	4.45	2	4.76	4	5.08
227	3.99	316	4.65	6	5.11	5	4.94
228	4.07	317	4.21	9	4.96	8	5.27
229	4.61	318	3.93	60	4.53	9	4.96
230	4.05	319	4.22	225	4.30	10	6.58
231	3.96	321	4.20	226	4.94	11	5.48
310	4.60	322	4.95	311	5.03	12	5.53
312	4.11	324	4.31	320	4.90	58	6.24
313	4.31	325	4.11			232	6.85
						323	5.23

From the above data, lettuce appears to be even more sensitive to soil acidity than alfalfa, being a total failure at most reactions below 4.6 pH, and producing less than 50 per cent yield at reactions below 5 pH. Response to lime is significant, even with soils between 6 and 7 pH.

Nitrogen. Although the results for the average of 28 soils where there was a direct comparison between LNPK and LPK treatments, showed an 83 per cent yield where nitrogen was omitted from the treatment, gains for nitrogen were very erratic, and on ten of the soils there was a significant decrease in growth when nitrogen was applied in the form of urea. The results on soils that might reasonably be expected to show nitrogen response for such a crop as lettuce should not be interpreted as an indication that these soils might not require fertilizer or manurial nitrogen under field conditions. In a greenhouse experiment there is abnormally rapid liberation of nitrogen from the total nitrogen reserve of the soils, which is in most cases relatively high. There was no provision for leaching the soils, such as naturally occurs, hence available nitrogen not taken up by the crop tends to accumulate in the soil. In our recently revised pot experiment technique, field conditions are more closely approximated by periodically leaching the soil.

It has also been shown that the urea treatments have tended to increase the acidity of the soil. This is at least a partial explanation of the depressing effect of urea on the growth of lettuce, which occurred in every case on the unlimed pots, and in several cases even when the soil was limed.

That there is some relationship between total nitrogen content of the soil and the available nitrogen is indicated by the nitrogen response data for lettuce. Thus the following soils showing significant nitrogen response have total nitrogen contents (in pounds per acre of surface soil) as indicated:

58-1746	232-3048
60-2272	317-2840
223-1986	322-2307
225-3782	323-3773
228-3150	

All of these nitrogen contents are below the average for the state (which is 4,000 pounds per acre of surface soil).

Phosphorus. This element is a very serious limiting factor for the growth of lettuce. The average yield on LNK treatments (phosphorus omitted) was but 57 per cent. The data is presented in Table XXV to show relationship with available phosphorus tests of the soil.

TABLE XXV. LETTUCE YIELDS WITHOUT PHOSPHOROUS FERTILIZATION AS RELATED TO PHOSPHORUS AVAILABILITY TESTS.

(Available Phosphorus, in Pounds Per 2,000,000 Pounds, Indicated After Serial Number of Soil.)

Total failure (less than 5% crop)	Practical failure (5-50% crop)		Serious decrease in yield without phosphorus (50-90% crop)		Little or no response to phosphorus (90% crop or more)
310-2	6-2	315-2	1- 2	226-20	5-10
318-2	60-4	316-4	2- 5	227-12	11- 7
	225-2	317-5	3-33	228- 7	12-15
	231-7	321-5	4-14	229- 6	223-57
	311-5	322-9	7- 8	230-10	224-15
	313-4	324-3	8- 6	312- 8	232-42
	314-9	325-3	9- 5	319- 5	323- 5
			10-10	320- 6	
			58-13		

While there are a few unexplained exceptions, there is a good general agreement between the percentage yield without phosphorus and the results of the laboratory tests.

Potassium. Potassium is in general slightly more in demand for lettuce on Connecticut soils than is phosphorus. The average yield on the LNP treatment (without potassium) is 50 per cent of the LNPK yields. Results, with figures following the soil serial number, are shown in Table XXVI.

TABLE XXVI. LETTUCE YIELDS WITHOUT POTASSIUM FERTILIZATION AND THE "EXCHANGE" POTASSIUM OF THE SOIL.

("Exchange" Potassium, in Pounds Per 2,000,000 Pounds, Indicated After Serial Number of Soil Whenever Data is Available.)

Practical failure (Crop 5-50%)		Serious decrease in growth (50-90%)	Little or no response to potassium (Crop 90% or more)
1-	314- 95	3-	5-
2-	315-109	4-	7-
8-	316- 78	6-	9-
58-	317- 98	11-	10-
226-111	318-133	60-	12-
228-166	319-132	223- 64	
232- 74	320- 85	225-116	
310-141	322-166	227-116	
311-176	323-122	229-214	
312-160	324- 72	230-116	
313- 93	325-156	231-240	
		321-344	

Figures as to "exchange" potassium are not available on soils 1 to 12 and it must be recalled that these were the ones that received sodium as part of the phosphorus treatment, which may account for the lack of response to potassium of five of this group. The only correlation to be observed is the appearance of all three soils containing more than 200 pounds per 2,000,000 of "exchange" potassium in the group with 50 to 90 per cent growth without potassium treatment

New York head lettuce was grown in the spring of 1930 in a series of fertilizer tests in .0001-acre concrete soil frames. The soil, of the Cheshire sandy loam type, is strongly acid and of low natural fertility. It was taken from an abandoned field now overgrown with broomsedge, cinquefoil and dewberry vines. Previous crops showed the following percentage yields with the omission of the various nutrients, as compared with lettuce:

	No lime	No nitrogen	No phosphorus	No potassium	Complete fert. and lime
Beets	0	70	90	56	100
Onions	5	77	76	32	100
Celery	0	79	26	71	100
Sweet Corn	75	59	94	95	100
Spinach	1	32	18	91	100
Tomatoes	88	59	28	96	100
Lettuce	13	43	23	92	100

It appeared that under outdoor conditions on this soil lettuce was less responsive to potassium than are beets, onions or celery.

The growth of lettuce in these soil frames is shown in Figure 65.

Tobacco

Tobacco of the Turkish type (selected because of its medium size, excellent uniformity and suitable habit of growth for greenhouse pots) has been grown on 51 different soils. It is a remarkably good crop to show nutrient deficiencies of the soil, since it shows both decrease in size of the plant and characteristic appearance of the leaves when an element is a limiting growth factor, or if there is some abnormal condition of the soil. This has been previously discussed by the author in a journal paper.[1]

Lime. Tobacco is apparently able to make normal growth on soils that are much too acid for many other crops. On 41 soils where there was a direct comparison between LNPK and NPK, the yield was 110 per cent without lime as compared with 100 per cent with lime. On the other hand there were certain very acid soils that were strikingly benefited by lime treatment. Such soils, notably Nos. 234, 237, 243, 337 and 340, showed an abnormal mottled appearance of the leaves when grown on unlimed pots. Analyses of the plants, chemical studies of the soil, and the similarity of growth with that which has been observed in both soil and solution cultures with the additions of abnormal concentrations of soluble manganese salts, have all confirmed the belief that this condition is due to the high soluble manganese content of these soils. This is corrected by liming, and soils less acid than about 4.6 pH have not shown this trouble. Figure 66 shows a typical plant grown on such a manganese-toxic acid soil.

[1] Morgan, M. F., Jour. Am. Soc. of Agron., 21: 130-136. 1929.

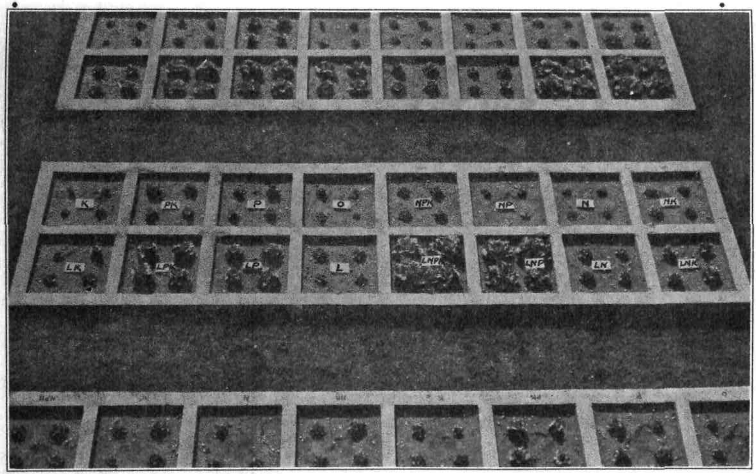

FIGURE 65. Soil frame experiment with New York head lettuce showing marked response to lime (L), phosphorus (P) and nitrogen (N), with slight response to potassium (K).

Nitrogen. While on the average tobacco has shown some response to nitrogen as grown in greenhouse pots without leaching (80 per cent yields on LPK treatments), the data is subject to the same abnormalities as for lettuce.

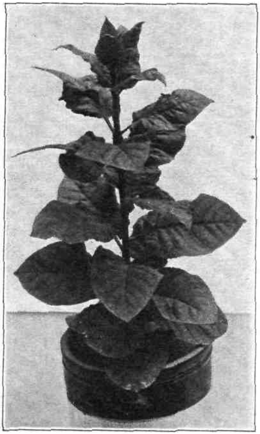

FIGURE 66. Tobacco plant grown on a very acid soil which contains a high concentration of soluble manganese.

Tobacco grown in 1930 on soils 334 to 343 inclusive, which were periodically leached, show much more consistent gains for nitrogen. This is indicated by a comparison of LPK yields on soils 310-325, none of which were leached or previously cropped in the greenhouse, with soils 334-342, leached both before and during the growing period.

TABLE XXVII. YIELDS WITHOUT NITROGEN ON UNLEACHED SOILS 310 TO 325 AND LEACHED SOILS 334 TO 342.

Serial No.	Percentage yield without N	Total N in soil in lbs. per 2,000,000	Serial No.	Percentage yield without N	Total N in soil in lbs. per 2,000,000
310	107	3,759	323	85	3,773
311	137	3,900	324	95	5,420
312	108	3,024	325	132	2,420
313	123	4,035	334	39	4,100
314	92	5,025	335	56	4,292
315	156	8,696	336	57	5,916
316	135	5,470	337	61	3,515
317	132	2,840	338	40	3,070
318	150	9,635	339	67	5,500
319	121	5,525	340	61	4,247
320	140	4,790	341	65	3,820
321	121	8,745	342	30	3,990
322	82	2,307			

In this connection it may be of interest to present the data for the nitrate nitrogen content of the first liter of the liquid leached from soils 310 to 325, subsequent to two crops of tobacco and one crop of lettuce grown in 1929.

TABLE XXVIII. NITRATE NITROGEN CONTENT OF LEACHATE FROM SOILS 310 TO 325, FEBRUARY 1, 1930 IN PARTS PER MILLION.

Soil serial No.	Unlimed		Limed	
	Without N	With N	Without N	With N
310	80	300	48	470
311	70	330	56	280
312	100	260	24	270
313	74	330	36	440
314	58	260	100	315
315	100	480	164	630
316	88	385	108	450
317	84	290	100	490
318	205	410	610	940
319	155	500	470	920
320	104	410	125	610
321	108	450	350	650
322	65	200	16	85
323	60	410	30	350
324	105	450	165	490
325	100	260	120	410

The failure of nitrogen to show increase, in fact, the general decrease in yield with nitrogen treatment on this group of soils is thus explained.

Phosphorus. Tobacco is extremely sensitive to low availability f phosphorus. The average yield without phosphorus on the 51 soils growing tobacco was only 33 per cent. There is a good general agreement between yields on treatments without phosphorus and the laboratory phosphorus availability test, as shown in Table XXIX.

TABLE XXIX. TOBACCO YIELDS WITHOUT PHOSPHORUS FERTILIZATION AS RELATED TO PHOSPHORUS AVAILABILITY TESTS.

(Available Phosphorus, in Pounds Per 2,000,000 Pounds, Indicated After Serial Number of Soil.)

Total failure (less than 5% crop)	Practical failure (5-50% crop)		Serious decrease in yield (50-90% crop)	Little or no response to phosphorus (90% crop or better)
225-2	226-20	242- 2	224-15	223-57
310-2	227-12	243- 5	246- 7	232-42
318-2	228- 7	245-12	312- 8	244-40
327-1	229- 6	311- 5	314- 8	334-46
337-3	230-10	313- 4	316- 4	
339-3	231- 7	315- 2	319- 5	
343-2	233- 2	317- 5	321- 5	
	234- 3	320- 6	322- 9	
	235- 2	324- 3	336-16	
	236- 3	325- 3		
	237- 2	335-16		
	238-10	338- 5		
	239-12	340- 7		
	240- 2	341-13		
	241- 2	342- 6		

Potassium. This element showed very marked gains on practically all soils, and with few exceptions the characteristic leaf-curl of potash-deficiency was in evidence on LNP treatments. It must be noted that tobacco showed more acute potash hunger on limed pots without potassium in the treatment than on corresponding unlimed pots. This will be explained later in connection with the data on the chemical composition of the tobacco from the greenhouse pots. The average yield for 51 soils on LNP treatments was 44 per cent as compared with LNPK pots.

TABLE XXX. TOBACCO YIELDS WITHOUT POTASSIUM FERTILIZATION AND THE "EXCHANGE" POTASSIUM IN THE SOIL.

(Exchange Potassium, in Pounds Per 2,000,000 Pounds, Indicated After Serial Number of the Soil.)

Practical failure (5-50% crop)		Serious decrease in yield (50-90% crop)	Little or no response to potassium (90% crop or more)
223- 64	241- 92	311-176	229-214
224- 34	242- 56	315-109	231-240
225-116	243-182	317- 98	321-344
226-111	244-132	318-133	334-474
227-116	245-131	319-132	
228-166	246- 77	324- 72	
230-116	310-141	327-155	
232- 74	312-160	335-142	
233-155	313- 93	336-110	
234- 73	314- 95	337-166	
235- 90	316- 78	338- 87	
236-148	320- 85	339- 98	
237-135	323-122	340- 97	
238- 85	325-156	341-172	
239- 72	342-151	343-170	
240- 51			

Beyond the fact that all of the four soils that have shown no significant response to potassium are higher than any of the other soils in exchange potassium, there is no evident correlation between the degree of response and the exchange potassium of soils containing less than 200 pounds per 2,000,000 pounds.

Chemical Composition of Turkish Tobacco Grown in Greenhouse Pots Under Various Conditions of Fertilization and Crop Response

In order to show the effect of various combinations of lime and fertilizers upon the composition of greenhouse tobacco grown in 1929, on soils 310 to 325 inclusive, the harvested crop was sorted on the basis of treatment and apparent symptoms of crop deficiency and chemical analyses were made under the direction of Dr. E. M. Bailey, in charge of the Department of Analytical Chemistry. The results are shown in Table XXXI.

TABLE XXXI. CHEMICAL COMPOSITION OF TURKISH TOBACCO GREENHOUSE POT EXPERIMENTS,
1929, Soils 310 to 325 (Moisture Free Percentages).

Treatment and crop condition	CaO	MgO	K_2O	Mn_3O_4	P_2O_5	N	Total crude ash
Leaves and Stems							
PK—yellow leaves	5.29	1.16	4.44	0.077	0.75	3.13	19.14
NK—very stunted	6.56	1.65	6.21	0.310	0.65	6.65	27.24
NP—leaves badly distorted	9.36	2.58	1.19	0.445	0.95	5.71	23.96
NK—slightly stunted	7.58	1.94	6.71	0.160	0.73	5.46	27.66
NP—leaves slightly distorted	8.29	2.06	1.58	0.300	0.79	5.75	23.30
PK—normal color	6.61	1.27	4.83	0.116	0.84	4.37	22.15
NP—normal leaves	8.13	2.49	2.05	0.180	0.81	5.27	22.72
NPK—normal plants	6.92	1.51	4.87	0.180	0.69	4.86	22.94
LPK—yellowed leaves	8.60	0.80	4.15	trace	0.71	3.96	23.67
LNK—very stunted	8.19	1.19	6.24	trace	0.58	5.83	29.48
LNP—leaves badly distorted	10.92	1.60	1.03	0.036	1.02	5.55	25.04
LNK—slightly stunted	8.76	1.13	5.04	trace	0.74	5.67	27.20
LNP—leaves slightly distorted	10.76	1.46	1.09	0.011	0.79	5.94	25.16
LPK—normal color	8.56	0.77	3.38	0.000	0.96	3.90	24.73
LNP—normal leaves	10.26	1.31	2.77	trace	0.83	5.09	25.87
LNPK—normal plants	9.44	1.01	4.40	0.014	0.81	4.98	25.62
Stalks							
PK—yellowed leaves	1.12	0.38	3.51	trace	0.43	1.05	8.15
PK—normal color	1.59	0.44	3.78	trace	0.56	1.42	9.51
NK—very stunted	...	...	...	....	0.53	4.12	22.65
NP—leaves badly distorted	3.74	1.36	2.00	0.116	0.51	2.82	11.58
NK—slightly stunted	2.37	0.75	7.73	0.014	0.50	3.04	17.54
NP—leaves slightly distorted	3.38	0.98	1.92	0.088	0.42	2.81	10.46
NP—normal leaves	2.21	0.87	3.27	0.024	0.46	2.46	10.24
NPK—normal plants	1.74	0.53	4.07	0.021	0.40	1.76	10.28
LPK—yellowed leaves	1.83	0.36	3.49	0.000	0.45	1.35	9.38
LNK—very stunted	...	...	...	....	0.43	2.48	18.61
LNP—leaves slightly distorted	3.93	0.64	1.59	0.000	0.53	2.75	9.84
LPK—normal color	1.99	0.28	2.58	0.000	0.49	1.16	8.02
LNP—normal leaves	3.02	0.50	2.50	0.000	0.48	2.20	9.85
LNPK—normal plants	2.32	0.37	3.29	0.000	0.37	1.92	9.91

This data enables one to make the following statements as to the effect of lime and increased availability of nutrient elements in the soil or added in the fertilizer upon the chemical composition of the tobacco plant:

Lime (in the form of pure magnesium-free calcium carbonate). Increases calcium and total crude ash, particularly of the leaf; decreases magnesium, potassium and manganese; has no significant effect upon phosphorus content of either leaves or stalks.

Nitrogen. Noticeably increases nitrogen, calcium and manganese content, and probably slightly increases potassium magnesium and total crude ash; has no consistent effect upon phosphorus.

Phosphorus. Very slightly increases phosphorus content of leaves, but not of stalks, if the soil is markedly deficient in this element; decreases crude ash content.

Potassium. Increases potassium content; decreases calcium and magnesium and phosphorus content; no significant effect upon manganese or total crude ash.

When other nutrients are supplied, plants not provided with:

- *nitrogen* show lower potassium, magnesium, calcium and crude ash contents, with an accompanying decrease in the nitrogen content.
- *phosphorus* show abnormally high crude ash, potash and nitrogen contents, with but slightly decreased phosphorus content.
- *potassium* show abnormally high calcium, magnesium and phosphorus contents, and strikingly low potassium content.

Oats

A crop of oats was grown after the first crop of tobacco in 1928 on soils 223 to 246. Nitrogen was then used in but one combination, the LNPK treatment. There had been a marked difference in the nutrient removal by the tobacco, and in the absence of nitrogen fertilization the growth of oats was practically in inverse proportion to the size of the previous tobacco crop. The data for soil 227 is typical:

Treatment	Tobacco gms. per pot dry wt.	Oats gms. per pot green wt.
O	1.53	111.5
P	17.58	68.5
PK	22.79	75.0
L	4.08	63.0
LP	1.17	69.0
LK	7.17	64.0
LPK	14.53	47.5
LNPK	15.23	118.0

For this reason it would be impossible to show any definite responses to lime, phosphorus and potassium. In all cases there was a very marked response to nitrogen and the growth of the untreated check plots was higher for 15 of the 24 soils than on the LPK treatments.

After obtaining these results, in subsequent trials nitrogen was added to all pots except the PK and LPK combinations. Oats was again grown in 1930 on soils 310 to 327 after a crop of sweet peppers. Again, in spite of the addition of nitrogen, diminished growth of the previous crop was the most important factor in producing increased oats yields in all cases except where there was a direct comparison between treatments without nitrogen and those with nitrogen. The only exception was the highly phosphorus-deficient soil No. 327, where the oats was almost a complete failure on treatments that omitted phosphorus.

On the basis of these results it appears that under greenhouse

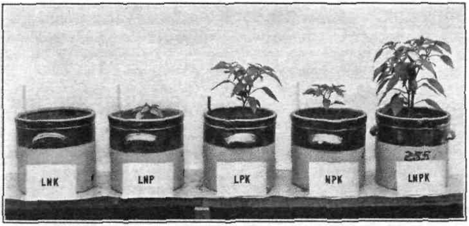

FIGURE 67. Sweet peppers in greenhouse pots of Gloucester fine sandy loam from typical unfertilized hay field in Eastern Highland, showing marked response of this vegetable to lime (L), phosphorus (P), potassium (K) and nitrogen (N).

conditions oats is a valuable crop to show nitrogen deficiencies of Connecticut soils, but is much less sensitive to lack of other nutrients, except in extreme cases.

Sweet Peppers

This crop has been grown in 1930 on greenhouse soils 310 to 327 and in .0001-acre concrete soil frames on Cheshire sandy loam at New Haven and a Wethersfield loam at Mount Carmel. The results have not been fully tabulated, but this crop is evidently an excellent one for use in indicating the nutrient deficiencies of the soils of this state. Figure 67 shows the typical growth on some of the treatments for one of the soils studied in 1930.

Preliminary observations indicate that peppers do well on most soils that are less acid than about 5 pH, but are seriously injured by more acid conditions, especially on soils that show any appreciable amounts of soluble aluminum or manganese. The crop is

less sensitive than tobacco to moderate phosphorus deficiencies, but is unable to set fruit on the more extremely phosphorus-deficient soils. On every soil the crop did very poorly without fertilizer potassium. This was also the case with nitrogen, although to a slightly smaller degree.

Carrots

This crop has been grown on soils 58 and 223 to 232. On only three of these soils, Nos. 224, 226 and 227, was there a significant response to nitrogen. However, this was prior to the adoption of the pot-leaching technique. Only four of the soils, Nos. 224, 226, 227 and 232, failed to show good response to phosphorus. These soils were the highest of the group in available phosphorus, as shown by the laboratory test. Only one soil failed to show gains for potassium. The crop was a practical failure except on soils less acid than 5.8 pH.

Other Crops

No other crops were grown on more than three different soils. The following table shows the percentage yields for these crops without the various nutrients, as grown in greenhouse pots or concrete soil frames.

TABLE XXXII. COMPARATIVE YIELDS ON TREATMENTS OMITTING THE VARIOUS NUTRIENTS.

(Percentages, with LNPK Yield = 100.)

Crop	Soil No.	Without lime	Without nitrogen	Without phosphorus	Without potassium
Sweet corn	60	50	80	30	75
	344	75	59	94	95
	346	84	58	80	81
Spinach	344	1	32	18	91
	346	84	58	80	81
Beets	58	100[1]	65	83	36
	344	0[1]	70	90	56
Onions	344	5	77	76	32
Tomatoes	344	88	59	28	96
Celery	344	0	79	26	71

[1] Soils 58 and 344 tested 6.2 and 4.8 pH respectively.

GENERAL SUMMARY

The results of the investigations of the Soils Department of this Station, which contribute to a better understanding of the physical and chemical character of Connecticut soils with respect to their suitability for crop production, their natural nutrient deficiencies, and the responses of important crops to lime and fertilizer applications, are brought together in this bulletin.

A number of terms used in soil description are defined to enable the writer to give a clearer picture of the prevailing soil conditions of the state. The effects of rock material, glaciation, climate, drainage, erosion, clearing and cultivation in producing soil differencies are also briefly discussed.

The chief differences between Connecticut soils as a group and those of other regions of the United States are explained on the basis of climatic effects in soil formation acting more slowly than usual on a rather resistant type of rock material which was almost completely disturbed during the glacial epoch.

The topographic features of the state are important in relation to soil distribution. The Eastern and Western Highlands; the Limestone Valley area within the Western Highland; the Central Lowland with included areas of trap-rock ridges; each presents a different range of soil conditions.

The more important characteristics of the groups of predominating soil types are briefly discussed, and a colored map showing the approximate location of the main areas of soils of these groups is appended to this bulletin. For practical purposes 19 groups are necessary in order to indicate soil differences of major significance.

A "key" is presented which shows the basis for classification of the soils of the state into soil series and types, depending upon color, texture, structure and arrangement of the various horizons of the soil profile and their relationships to parent rock, mode of deposition of the parent soil material, topography, drainage conditions and the occurrence of stones or boulders. Such a classification enumerates 50 named soil series, comprising 176 types and phases. A detailed soil map of the state would picture at least this number of distinct soils.

In order to show any relationships that may exist between the more important of the above soil types and the present use of the land for crops, pasture and woodland, 15 areas well distributed over the state were carefully mapped as to soil and land cover. This was supplemented by soil and farm plan maps of 190 dairy farms in eight towns of the Eastern Highland.

The present use of an area of a given soil depends not only upon the inherent quality of the soil, but upon its relation to areas of other better or poorer soils, both on the farm and in the town as a whole.

The physical factors of soil type are apparently of paramount importance in determining the present adjustment of land use to soil. These factors are: stoniness; degree and diversity of slope; texture and structure of the soil and subsoil; character of the underlying material (boulder till, gravel, sand or clay); water-holding capacity and drainage conditions of the soil.

The major groups of soil are briefly discussed with reference to the leading agricultural enterprises: dairying, orcharding, small fruits, vegetables, potatoes, tobacco, alfalfa, grass hay, corn, pasture and forest.

An estimate of the present distribution of land use of the major soil types of the state is presented.

A tabulation of the soil series occurring on the 190 dairy farms in eastern Connecticut shows a considerable degree of selection of certain soils for productive use, with the relegation of the less-favored soils to brush pasture and woodland. Thus 44 per cent of the Charlton soils are improved, as compared to only 18 per cent of the Gloucester soils. These two soil series represented 46 per cent of the entire area included in these farms.

The chemical composition of a large number of samples of surface soil representative of the important soil types of the state, has been studied in detail with respect to the following factors: organic matter and nitrogen; total and available phosphorus; total and "replaceable" potassium; calcium and magnesium; acidity, lime requirement and their relationship to soluble aluminum and manganese.

An average acre of Connecticut surface soil contains approximately:

4,000 lbs. of nitrogen
1,800 lbs. of phosphorus
29,000 lbs. of potassium

with an acidity of 5.3 pH, requiring 2.75 tons of agricultural limestone to effect its neutralization.

As compared to the above averages, which also represent the more common conditions for soils used for general crops and mowing, the tobacco soils are lower in nitrogen, potassium and lime requirement and much higher in phosphorus. On the other hand, soils from permanent pasture fields are commonly higher in potassium and lime requirement and lower in phosphorus than the average for the state.

With respect to soil type or soil series, there are few indications of a consistent superior nutrient fertility in any case. There are some differences in nitrogen and organic content that show a relationship to soil type, as would be expected from their characteristic conditions with respect to moisture and textural class. Except in extreme cases such as the very sandy Merrimac, the very heavy

Suffield, or the poorly drained Whitman soils, under the same conditions of cultural history any one soil type of the state may show the same conditions of both total and available nutrients as any other.

A further estimate of the conditions of the prevailing soil type with respect to availability of nutrients and responses to lime, nitrogen, phosphorus and potassium, may be obtained from the results of pot experiments with 19 different soils, representing 35 soil types, and soil frames in the field representing two soil types. During the past five years the following crops have been grown on one or more of the above soils: alfalfa, lettuce, tobacco, oats, buckwheat, sweet peppers, carrots, sweet corn, spinach, beets, onions, tomatoes and celery.

The above crops vary greatly in their relative response to lime and fertilizers on the different soils. However, they all contribute to revealing the general low availability of soil nutrients and the need for lime on soils from fields that have not been heavily fertilized and limed during recent years. In general the pot and soil frame experiments show the same results as would have been predicted from the chemical studies as to soil acidity, available phosphorus, replaceable potassium and calcium, and soluble manganese and aluminum.

A greenhouse pot technique has now been adopted that permits the periodic leaching of the soil and the analysis of the leachate for such pertinent conditions as nitrate nitrogen, phosphorus, potassium, calcium, magnesium, aluminum and manganese. In the future it is hoped that this will furnish a more complete knowledge of the actual nutrient status of soils under investigation.

The greenhouse pot experiments have failed to show differences in the available nutrient supply of the soil, which are characteristic of soil types, except in the case of the naturally less-acid Dover soil. This is in accordance with the results of chemical studies. However, under field conditions, soils of two different types may be expected to show a consistent difference in capacity for economic crop production even though they are both equally deficient in plant nutrients. This is due to other limiting factors, such as poor moisture holding ability, failure to retain fertilizer applications against leaching, and unfavorable physical conditions such as irregular topography, stoniness, or excessive gravel, sand, or clay, which may exist to a greater degree on one soil than another. Both soils may need liberal fertilizer and lime applications, but on only one can the farmer obtain results that make it a profitable soil for the crop he is producing. Such factors are clearly distinguished in the classification of soil types now used in soil survey work.

INDEX TO ANNUAL REPORT

FOR THE YEAR ENDING OCTOBER 31, 1929

PAGE

Acidity of Connecticut soils 887
Acredula caudata 617
Adelges abietis 496, 502, 503, 505, 506
pinicorticis 496
Aedes canadensis 613
sylvestris 612, 613
triseriatus 613
Agrilus 503
anxius 495
Agromyza clara 496
Alfalfa, nutrient requirements of 894
Alsophila pometaria 492
Aluminum supply in Connecticut soils 889
American Agricultural Chemical Co., feeds 655, 739
fertilizers, 10, 11, 22, 24, 26, 27, 28, 39, 42, 44, 47, 48, 56, 57, 58, 62, 70, 72, 100
American Cyanamid Co. 11, 26, 27
American foul brood 521
American Maize-Products Co. 655
American Milling Co. 655, 656, 685, 688, 693, 694, 708, 713
Analytical chemistry, list of publications, 1877-1927 135
Anasa tristis 495
Anglo-Chilean Nitrate Sales Corp. 11
Anisota rubicunda 503
stigma 503
Anomala orientalis 395, 486, 499, 590, 599
Anopheles punctipennis 612, 613
quadrimaculatus 612
Anthrenus scrophulariae 499
Anuraphis roseus 491
Aphis pomi 491
Apiaries, inspection of 519
Aporia crataegi 518
Apothecaries Hall Co., fertilizers 11, 22, 24, 26, 27, 28, 31, 33, 39, 40, 41, 42, 44, 46, 47, 48, 49, 54, 55, 56, 57, 58, 61, 62, 66, 72
Apple sprays, test of 569
Aquatic flies 587
Aramigus fulleri 585
Arcady Farms Milling Co. 656, 688, 689, 694, 695, 708, 713
Archer-Daniels Midland Co., feeds 656, 678
Archips cerasivorana 500
rosana 497, 614
Argyresthia thuiella 495
Armour Fertilizer Works, 12, 22, 24, 26, 27, 28, 39, 42, 44, 47, 48, 57, 61, 62, 72, 93, 100
Aromatic spirits of ammonia 810
Aserica castanea 500, 590, 592, 597, 599, 607
Ashcraft-Wilkinson Co., feeds 656, 678
fertilizers 12, 31, 34, 35
Asiatic beetle quarantine 599
Asiatic garden beetle 607

PAGE
Aspidiotus perniciosus 491
Associated Seed Growers, Inc., fertilizers 12, 22, 24, 39, 42, 72, 74
Asterolecanium variolosum 497, 617
Atlantic Coast Fisheries Corp. of New York, feeds 656, 739
Aulacaspis pentagona 498
rosae 492
Autographa brassicae 494
Babcock glassware, etc. 821
Bacillus larvae 521
pluton 520
Bailey, E. W., & Co., feeds 656, 695, 708, 713
Baker Castor Oil Co., fertilizer 12, 28, 29
Barrett Co., fertilizers 12, 22, 24, 26, 27
Bartlett, F. A., Tree Expert Co., fertilizers 12, 74
Basic slag 11, 39, 40
Bay State Milling Co. 656
Beach Soap Co., feeds 656
Beacon Milling Co., Inc. 657, 689, 695, 711, 713, 714, 715
Beers, Ira W., feeds 657, 715, 716
Bees, registration of 527
Beets 820
Benacus griseus 500
Berkshire Chemical Co., fertilizers 12, 13, 22, 24, 27, 29, 39, 42, 44, 47, 48, 56, 57, 62, 74, 100
Berry breeding, summary of 760
Beverages, soda water type 780
malt, near beer type 780
Biochemistry, list of publications to 1927 138
Black rootrot, resistant shade tobacco 256
Blatchford Calf Meal Co. 657, 711
Blissus leucopterus 499
Blister rust, *see white pine.*
Board of Control, letter of transmittal and report v
members, 1877-1927 125
Bone meal 57, 62
Botany, list of publications to 1927 154
B. Paul's Henna 817
Brachyrhinus ovatus 498, 504
sulcatus 498, 504, 585
Bridge's, Amos D., Sons, Inc., feeds 657, 695
fertilizers 13, 74
Bristol Grain & Supply Co., feeds 657, 715, 716
Brode, F. W., Corp., feeds 657, 678
fertilizers 13, 31, 35
Broder, L., Grain Store, feeds 657, 695
Brown rootrot of tobacco, field experiments 247
Buckingham, C., & Co., feeds 657, 695
Buell, C. E., Inc., feeds 658, 739
Buffalo Flour Mills Corp., feeds 658
Bulletins, Station, list of 1877-1927 129
Burckhalter, C. W., Inc., feeds 658, 739
Calophasia lunula 518
Calcium nitrate 22, 25
Calcium supply in Connecticut soils 886
California Hawaiian Milling Co., feeds 658, 716
Calurea 22, 25
Campbell, C. W., Co., feeds 658, 689, 695, 717
Camphor, spirit of 812

PAGE
Canada-Leaming corn, characteristics 190
maturity 191
yield of grain 191
origin 189
production of seed 189
silage corn variety test 193
Canada Linseed Oil Mills, Ltd., feeds 658, 678
Caple, A. B., Co., feeds 658
Carpocapsa pomonella 493
Carrots, nutrient requirements of 908
Case, A. H., & Co., Inc., fertilizers 13, 93, 100
Castor pomace 27, 28
Catalpa bungei 496, 498
Celastrus 503
Cell chemistry, reference to papers 756
Cel-o-glass seed bed sash 273
Ceratomegilla fuscilabris 584
Cereal products, etc. 781
breakfast foods, etc 780
flour, bread, etc. 787
Chapin & Co., feeds 658, 689, 695, 717
Chaoborus punctipennis 588
trivittatus 588
Chestnut blight 757
Chionaspis euonymi 498
pinifoliae 496, 578
Chittenden, E. D., Co., fertilizers 13, 27, 29, 74
Chrysochus auratus 500
Clinton Corn Syrup Refining Co. 658, 685
Clyde Renco Milling Corp. 658, 695, 696
Coffee, Dacosta 787
Al-Mo-Co. 788
Coleophora laricella 495
Coles Co., feeds 658, 696, 708, 717
Collis Products Co., feeds 659, 739
Colopha ulmicola 496
Conkey, G. E., Co., feeds 659, 696, 697, 717, 718
Connecticut Fat Rendering & Fertilizer Corp., feeds 659, 740
fertilizers 13, 57, 61
Conotracaelus nenuphar 493
Consolidated By-Products Co., feeds 659, 740
fertilizers 13
Consolidated Rendering Co., feeds 659, 740
fertilizers 13, 22, 24, 26, 27, 29, 39, 42, 44, 47, 48, 56, 57, 61, 62, 93, 100
Contarinia pyrivora 492
Convention of entomological workers 500
Coöperative GLF Exchange, Inc., feeds 659
Copeland Flour Mills, Ltd. 659
Corn, Canada-Leaming 185
reference to studies in breeding 759
Corn Products Refining Co., feeds 659, 685
Cottonhull ashes 45, 50
Cottonseed meal, fertilizer 31, 33
Cowles, C. A., feeds 659, 697, 719
Cox, Chas. M., Co., feeds 659, 679, 681
Crambus leachellus 616
Crataegus 503, 504, 505

PAGE

Crepidodera helxines ... 503
Crioceris asparagi ... 494
Cristulariella depraedans, see maple leaf disease ... 621
Crosby Milling Co., feeds ... 660, 683, 697, 709, 719
C. & R. Sales Co., fertilizers ... 13, 74
Cryptorhynchus ... 503
Ctenocephalus canis ... 499
Culex pipiens ... 612, 613
Cytisus ... 503
Damping-off of tobacco seedlings ... 269
vegetable seedlings ... 757
Dasyneura rhodophaga ... 615
Davey Tree Expert Co., fertilizers ... 14, 74, 100
Davis, R. G., & Sons, Inc., feeds ... 660, 697, 689, 709, 719
Decatur Milling Co. ... 660
Delaware Mills, Inc. ... 660, 697, 709, 719, 720
Denver Alfalfa Milling and Products Co. ... 660, 689
Dr. Depew's Prescription 10, 010 ... 817
Dermestes vulpinus ... 500
Dewey Bros. Co., feeds ... 660
Diabrotica vittata ... 494
Diarthronomyia hypogaea ... 498
Dilachnus strobi ... 496
Director, report of ... 749
Dominion Flour Mills, Ltd. ... 660, 679, 681
Doz-it ... 817
Dry ground fish ... 56, 58
Dry Milk Co., feeds ... 660, 740
Drug products, report ... 773
appropriation ... ix
Duluth-Superior Milling Co. ... 660, 679, 683
Eastern Grain Co. ... 661, 741
Eastern States Farmers' Exchange, feeds 661, 697, 689, 698, 709, 711, 720, 721
fertilizers 14, 22, 24, 26, 27, 39, 41, 42, 44, 47, 48, 49, 54, 55, 56, 57, 58, 61, 62, 66, 76
Edwards, S. T., & Co., Inc., feeds ... 661, 741
Eggert, Ed. ... 14, 45, 50
Eggs ... 788
Elmore Milling Co. ... 661, 690, 698, 699, 709, 711, 721
Emphytus cinctus ... 518
Employees of the Station, 1877-1927 ... 125
Entomologist, report ... 479
Entomology, list of publications to 1927 ... 164
Entomosporium ... 506
Epiblema suffusana ... 614
Epicauta marginata ... 494, 499
Epilachna borealis ... 494, 583
corrupta ... 493, 581, 583, 584
Epitrix cucumeris ... 494, 499, 503
Eriococcus azaleae ... 504
Eriophyes pyri ... 493
Eriosoma lanigerum ... 491
Eshelman, John W., & Sons, feeds ... 661, 662, 681, 690, 699, 709, 721, 722
Essex Fertilizer Co. ... 14, 76
Ethyl nitrite, spirit of ... 813
Eulia velutinana ... 492

PAGE

Euonymus 503, 504
European corn borer 563
European foul brood 520
Euvanessa antiopa 495
Evans Milling Co. 662, 685
Exhibits, entomology 487
Fairchild Milling Co. 662
Fairmont Creamery Co. 662, 741
Farmers Feed Co. 662, 687
Fats and oils:
  butter 788
  oleomargarine 788
  olive oil, etc. 789
Feeds, analyses, official samples 678
    unofficial 744
  law 653
  miscellaneous materials 748
  registrations 655
  terms used in analyses 654
Fenusa pumila 486, 496, 504, 505
Fertilizer, analyses, collaborative work 93
    check samples 93
    chlorine in 106
    classification of samples analyzed 21
    containing ammonia, phosphoric acid and potash, analyses of 70
    containing nitrogen and phosphoric acid, analyses of 66
    containing nitrogen and potash 66
    containing phosphoric acid and potash 66
    definitions and standards for some materials 7
    gratuitous analyses of 6
    inspection of 21
    law, provisions of 3
    miscellaneous materials, analyses of 93, 104
    mixed, analyses of 67, 70
    precautions to be observed in drawing samples of 5
    registrations 10
    special and home mixtures 93, 94
Field and lawn insects 499
Flory Milling Co., Inc. 662, 699, 700, 722, 723
Food products, report 773
    appropriation ix
Foods, special and miscellaneous 789
Forbes, A. W., feeds 662, 699, 723
Ford Motor Co., fertilizers 15, 26, 27
Forest planting stock, distribution 754
Forestry, list of publications to 1927 178
Friedman Tobacco Products Corp., fertilizers 14, 76
Frisbie, L. T., Co., feeds 662, 741
    fertilizers 14, 76
Fruit, insects 491
  products:
    cider 794
    grape fruit juice 794
    grape juice, etc. 794
Fundulus heteroclitus 613
General Mills, Inc., feeds 662, 663, 679, 681, 683, 700, 723
Gillettea cooleyi 496, 502, 503, 505, 506

PAGE

Gipsy moth work in Connecticut 529
cost of spraying woodland 543
Glypta rufiscutellaris 441
Gnomonia ulmi 505
Gorton-Pew Fisheries Co., Ltd., feeds 663, 741
Grandin, D. H., Milling Co., feeds 663, 700, 723
Grasselli Chemical Co., fertilizers 15, 78
Gryllotalpa hexadactyla 500
Habrolepis dalmanni 617
Hafleigh & Co., feeds 663, 741
Hales & Hunter Co., feeds 663, 723
Hall's Muneac 817
William Hamilton & Son, Inc., feeds 663
Hecker H-O Co., Inc., feeds 663
Hecker-Jones-Jewell Milling Co. 663, 679, 681, 683
Helicobia (Sarcophaga) helicis 584
Heliophila unipuncta 495
Heliothis obsoleta 494, 567
Honey 794
Household insects 499
Hubinger, J. C., Bros. Co., feeds 664
Hudson, L. W., feeds 664, 700, 724
Humphreys-Godwin Co., feeds 664, 678
fertilizers 15, 31, 35, 36, 37
Hylemyia brassicae 495
Hyper humus 220
Hyphantria cunea 495
Ice cream, etc. 794
analyses of 796
Icerya purchasi 498
Idiopterus nephrelepidis 615
Imperial Grain & Milling Co. 664, 690
Index, general, to annual reports, 1877-1927 113
Index, general, to analyses of miscellaneous materials with reference to manurial value, 1877-1927 113
Insect pests, appropriation x
miscellaneous 500
revised law 604
Insects attacking flowers and greenhouse plants 498
ornamental shrubs and vines 497
International Agricultural Corp., fertilizers 15, 78
International Milling Co., feeds 664, 680, 681
Iodine, tincture of 814
Jams and jellies 794
Japanese beetle, quarantine 592
scouting 589
soil treatment 589
Jersee Co., feeds 664, 712, 724
Joynt, John, fertilizers 15
Judith Milling Co. 664
Kalmia latifolia 515
Kansas Flour Mills Corp. 664
Kasco Mills, Inc., feeds 664, 700
Kellogg Co., feeds 664, 685
Kelloggs & Miller, Inc., feeds 664, 679
fertilizers 15
Kellogg, Spencer, & Sons, Inc., feeds 664, 679
fertilizers 5, 27, 29

PAGE
Kermes galliformis 497, 615
Key to Connecticut soil types 857
King, H. H., Flour Mills Co. 664, 683
Krause, Chas. A., Milling Co. 664, 686, 701, 724
Labieniec, S. F., feeds 665, 724
Land O'Lakes Creameries, Inc. 665, 741
Larabee Flour Mills Co. 665, 680
Larrowe Milling Co. 665, 687, 688, 701, 712, 724, 725
Laspeyresia molesta 485, 493
Lecanium corni 492
nigrofasciatum 497
Lepidosaphes ulmi 496
Leptinotarsa decemlineata 494
Lettuce, nutrient requirements of 897
Leucaspis japonica 497
Limestone, fertilizers 93, 102
Lime water, analyses of 811
Lines, C. W., Co., feeds 665, 701, 725
Linseed meal, fertilizers 32, 38
Litchfield County Coöp. Assoc., feeds 665, 701, 725
Lithocolletes hamadryadella 495
Long Hill Feed Store 665, 701, 725
Lonicera 503
Lovitt, L. B., & Co., feeds 665
fertilizers 15
Lowell Fertilizer Co. 15, 78
Lyctus opaculus 500, 614
Lygaeonematus erichsoni 496
Lygidea mendax 491
Lygus pratensis 498
Lysimeter, installation 204
leaching experiments 762
Macrocentrus ancylivora 438
Macronoctua onusta 498
Magnesium citrate, solution of 814, 815
Magnesium, supply in Connecticut soils 886
Maine Farmers' Exchange, fertilizers 15, 78
Malacosoma americana 492
Mamestra picta 494
Manchester, E., & Sons, feeds 665, 681, 683, 701, 725
Manganese, supply in Connecticut soils 889
Mann Bros. Co, feeds 666, 679
Mansonia perturbans 612
Mapes Formula & Peruvian Guano Co., fertilizers 15, 16, 27, 30, 78
Maple leaf disease 621
causal organism, *Cristulariella depraedans* 628
bibliography 646
review of literature 626
statements of investigators 637
synonomy and exsicatti 629
discovery in Connecticut 625
where found 625, 631
mycological investigation 630
tree studies ....
chemical treatment to force leafing 639
inoculation and infection 643
Marianna Sales Co, fertilizers 16, 31, 37
Maritime Milling Co., Inc 666, 681, 691, 701, 725, 726

PAGE

Markham, A. G., & Co., feeds 666, 742
fertilizers 16, 80
Marsh, Geo. E., Co., feeds 666, 742
Marsonia juglandis 505, 506
Martinis, C. J., Grain Co., feeds 666, 687
Meader Milling Co., Inc., feeds 666
Meat products, hamburg steak 804
frankfurts 805
pork sausage 805
meat loaf seasoning 805
Meech & Stoddard, Inc., feeds 666, 684, 691, 701, 709, 726, 727
Melalopha inclusa 504
Melanotus sp. 499
Melittia satyriniformis 494
Memorial, Thomas B. Osborne, *see Osborne, Thomas B.* 275
Memphis Cottonseed Products Co., feeds 667
Mennel Milling Co. 667, 701, 702, 727
Mexican bean beetle 493, 581
Middleport Flour Mills, Inc. 667
Milk and milk products, market milk 805
chocolated skimmed milk 806
buttermilk, semi-solid 806
evaporated milk 806
powdered whole milk 806
cream 806
Millane Tree Expert Co., fertilizers 16, 80
Milmine, Bodman & Co., Inc., feeds 667, 688
Milorganite 18, 66
Miner, Hillard Milling Co. 667, 686, 687, 691
Monarthropalpus buxi 497
Moon, Geo. Q., & Co., Inc., feeds 667, 680, 682, 686, 702, 709, 727
Moran-Patton Co., feeds 667, 727
Morse, Fred C., feeds 667, 691, 702, 709, 727, 728
Morse, James F., & Co., feeds 668, 742
Mosquito elimination, report 608
appropriation xi
Mount Vernon Milling Co. 668, 686
Myzus cerasi 491
ribis 491
National Milling Co. 668, 684
Natural Guano Co., fertilizers 16, 93, 100
Nebraska Consolidated Mills Co. 668, 680
Neodiprion pinetum 496
Nepticula sericopeza 495
New England By-Products Corp., feeds 668, 742
New England Fertilizer Co. 16, 80
Newman Bros. Grain Co. 668, 728
Newsome Feed & Grain Co. 668
Newton Feed Co. 668, 709
Niagara Falls Milling Co. 668, 680, 682
Nitrate of soda 22, 24
and potash 54, 55
and phosphoric acid, materials containing 66
Nitrogen, supply in Connecticut soils 860
Nitrophoska, fertilizers 19, 86
Normacol 817
Northwestern Consolidated Milling Co., feeds 668, 682, 684
Notolophus antiqua 518

PAGE
Nowak Milling Corp., feeds 668, 691, 703
Nursery stock, imported, inspection of 516
Nurseries, inspection of 516
Nutrition studies 756
Oats, nutrient requirements of 906
Ogilvie Flour Mills Co., Ltd. 669, 680, 682
Oil sprays, for killing European red mite eggs 571
against aphids and European red mites 576
Old Deerfield Fertilizer Co. 16, 66, 80
Olds & Whipple, Inc., fertilizers 16, 22, 24, 26, 27, 30, 39, 41, 42, 44, 46, 48, 54, 55, 56, 57, 58, 62, 66, 80, 93, 100
Olethreutes hebesana 498
Ontario Milling Co., Inc. 669, 691, 703, 709, 728, 729
Organic matter, supply in Connecticut soils 887
Oriental peach moth in Connecticut 395
appearance of the moth 404
field controls 428
summary 435
habits 406
history in the United States 401
laboratory experiments 413
length of life periods 412
parasites 436
recommendations as to control 436
references to literature 445
seasonal life history 410
Ormenis pruinosa 504
Orthopodomyia signifer 613
Oryzaephilus surinamensis 500
Osborn, S. V., Est., feeds 669, 691, 729
Osborne, Thomas B., memorial 275
bibliography 377
"Dr. Osborne As An Associate" 281
honors and memberships 348
obituaries 358
photograph 276
retirement 356
selected papers 291
"Work of Thomas Burr Osborne" 283
Pacific Manure & Fertilizer Co. 17, 93, 100
Pantamorus godmani 499, 585
Papaipema nitela 494, 568, 616
Paradexodes epilachnae 584
Parasites, Oriental peach moth 436
Paratetranychus pilosus 493, 571
ununguis 497
Park & Pollard Co., feeds 669, 682, 691, 703, 709, 710, 712, 729
Parmenter & Polsey Fertilizer Co. 17, 80
Parus caerulens 617
Patent Cereals Co. 670, 686
Pecos Valley Alfalfa Mill Co. 670, 691
Pegomyia hyoscyami 495
Peppermint, essence of 816
Peppers, nutrient requirements of 907
new variety 760
Peridroma margaritosa, var. *saucia* 498
Phlyctaenia ferrugalis 498
Phorocera claripennis 584

PAGE

Phospho tobacco 43
Phosphorus, supply in Connecticut soils 880
Phyllocoptes schlectendali 497
Phyllophaga sp. 499, 602, 614, 617
 fusca 499, 617
 gracilis 499
Phytomyza aquilegiae 498
Piedmont-Mount Airy Guano Co., Inc., fertilizers 17, 82
Pillsbury Flour Mills Co. 670, 680, 682, 683, 684, 703
Pine leaf scale 578
Pinus sylvestris 579
Pissodes strobi 496
Pittsburgh Plate Glass Co., feeds 670, 679
Pityogenes hopkinsi 496
Plagiodera versicolora 496, 504, 506
Plant breeding, list of publications to 1927 180
Platt, Frank S., Co., feeds 670, 729
 fertilizers 17, 82
Plutella maculipennis 494
Podisus maculiventris 584
Poecilocapsus lineatus 498
Poison, materials examined chiefly for 818
Pontia rapae 494
Popillia japonica 500, 590, 591, 592
Postum Co., Inc., feeds 670, 686
Potash, carbonate of 44, 46
 fertilizer experiments, tobacco 207
 muriate of 44, 47, 48
 sulfate of 44, 48
Potash-magnesia, sulfate of 44, 49
Potassium, supply in Connecticut soils 883
Potatoes 820
Potter, W. N., & Sons, Inc., feeds 670, 729
Pratt Food Co. 670, 686, 691, 703, 729, 730
Precipitated bone 39, 41
Premier Poultry Manure Co. 17, 93, 100
Prociphilus imbricator 496
Projects of Station, list for 1929-1930 766
Protein chemistry, reference to papers 756
Prunus pissardi 503
Pseudococcus citri 498
Psila rosae 495
Psylla pyricola 491
Pteronidea ribesi 485
Ptinus fur 500
Publications, departments, list of, 1877-1927 135
 analytical chemistry 135
 biochemistry 138
 botany 154
 entomology 164
 forestry 178
 plant breeding 180
 soils 183
 tobacco substation 184
 Station, list of, 1929 768
Puffer, H. C., Co., fertilizers 670, 703
Pulverized Manure Co., fertilizers 17, 93, 100
Pulvinaria vitis 497

PAGE

Pyrausta nubilalis 494, 564, 568
Quaker Oats Co. 671, 687, 691, 692, 704, 710, 712, 731
Quercus prinus 617
Rackliffe Bros. Co., Inc., fertilizers 17, 82
Rainbow Forest 758
Ralston Purina Co. 671, 672, 687, 692, 704, 710, 711, 712, 731, 732, 733
Reardon, John, & Sons Co., feeds 672, 743
Red Wing Milling Co. 672
"Refection" in rats, study of 756
Registrations, list of commercial feeding stuffs 655
fertilizers 10
Report, Board of Control, letter of transmittal v
commercial feeding stuffs 649
fertilizers 1
director 749
in account with mosquito elimination appropriation xi
in account with tobacco research appropriation xii
in account with white pine blister rust appropriation xiii
entomologist 479
tobacco substation 197
treasurer vii
in account with insect pest appropriation x
in account with food and drug appropriation ix
Rhagoletis pomonella 492
Rhinichthys astronasus 613
Rhizoglyphus hyacinthus 499
Rhubarb, compound mixture of 816
Rhyacionia buoliana 495, 614
Ribes 506, 515
nigrum 516
Robin Hood Mills, Ltd. 672, 681, 683
Rockville Grain & Coal Co. 672, 692, 733
Rogers & Hubbard Co., feeds 672, 743
fertilizers 17, 22, 24, 39, 42, 57, 62, 82
Rolf, Fred H., Inc., feeds 672, 733
Rosa manetti 672, 733
rugosa 517
Royal Milling Co. 672, 681
Royster, F. S., Guano Co., fertilizers 17, 18, 84, 93, 100
Ruhm Phosphate & Chemical Co., fertilizers 18
Russell-Miller Milling Co. 672, 681, 684
Russia Cement Co., feeds 672, 743
Sacbrood 522
St. Lawrence Flour Mills Co., Ltd., feeds 674, 681
St. Albans Grain Co. 673, 674, 683, 684, 685, 687, 692, 693, 705, 711, 713, 734, 735, 736
Saperda 503
Satin moth 605
Scott, A. W., Co., feeds 672, 733
Seed testing 755
Serica 607
parallela 607
sericea 607
Seymour Grain & Coal Co. 672, 704, 733
Sewerage Commission of the City of Milwaukee, fertilizers 18, 66
Shade and forest tree insects 495
Sheep manure 93, 100
Shelton Feed Co. 672, 733

PAGE
Shoemaker, M. L., & Co., Inc., feeds 673, 743
fertilizers 18, 57, 62, 66, 84
Shortening rest period of potted maples, chemical treatment for .. 639
Slugg, W. G., feeds 673, 743
Smith, Winchell, Inc., feeds 673, 704, 705, 733
Soil reaction, seasonal fluctuations on tobacco plots 264
Soils department, list of publications to 1927 183
Soils of Connecticut 825
causes contributing to differences 837
characteristics of important groups 846
chemical composition 877
acidity and lime requirement 887
aluminum and manganese 889
calcium and magnesium 886
organic matter and nitrogen 877
phosphorus, total and available 880
potassium, total and replaceable 883
compared with other regions 842
distribution of important groups 846
key to soil types 858
utilization 870
nutrient requirements 891
alfalfa 894
buckwheat 897
carrots 908
lettuce 897
oats 906
other crops 908
sweet peppers 907
tobacco 900
summary 909
terms of description 831
topographical features 844
Sovitsky, Ike, feeds 673, 705, 711, 734
Sphecodina abbotii 497
Spinach, new variety 760
Spratt's Patent (Amer.), Ltd., feeds 673
Spray service 755
Springfield Rendering Co., feeds 673, 743
fertilizers 18, 84
Squash, straightnecked, new variety 760
Staley, A. E., Mfg. Co., feeds 673, 685
Standard Milling Co. of Canada, Ltd. 673, 683
Standard Wholesale Phosphate & Acid Works, Inc., fertilizers 18, 20, 22, 24, 26, 27, 30, 39, 42, 44, 47, 56, 57, 58, 61, 63, 84
Stanley, John T., Co., Inc. 673, 743
Stilpnotia salicis 605, 606
Stiretrus anchorago 584
Struven, Chas. M., & Co., feeds 674, 743
Superphosphate (acid phosphate) 39, 42
Swift & Co. Fertilizer Works 19, 84
Synthetic Nitrogen Products Corp. 19, 22, 23, 25, 55, 86
Syracuse Milling Co. 674, 683, 693, 706, 711, 736, 737
Talcott, D. L., feeds 674, 706
Tankage 57, 61
Tarsonemus pallidus 499
Tennessee Copper & Chemical Corp., fertilizers 19, 86
Tetranychus bimaculatus 499

PAGE
Thermobia domestica 500
Thomas, I. P., & Son Co., fertilizers 19, 22, 25, 39, 43, 44, 48, 57, 63, 66, 86, 93, 100
Thielavia basicola 256
Thomaston Supply Co., feeds 674, 706, 737
Tioga-Empire Feed Mills, Inc. 675, 693, 706, 711, 713, 737
Tmetocera ocellana 492
Tobacco, analyses of 818, 819
appropriation xii
breeding 760
nutrient requirements of 900
substation ....
list of publications to 1927 184
report 197
black rootrot resistant shade 256
brown rootrot, field experiments 247
Cel-o-glass seedbed sash 273
chemical investigations 234
chemical composition of a good burning crop compared with poor burning 228
damping off of young seedlings 269
Hyper Humus 220
manure as supplement to commercial fertilizer 216
potash fertilizer experiments 207
soil reaction, seasonal fluctuations 264
tractor in raising crop 271
Tolype velleda 492
Tortrix albicomana 614
Toumeyella liriodendri 497
Tractor, raising tobacco crop 271
Trader's Feed and Grain Co., Inc. 675
Treasurer, report vii
Trialeurodes packardi 492, 614
Trichogramma minuta 441
Triton Oil and Fertilizer Co. 19, 22, 25, 86
Tsuga canadensis 578
Ubiko Milling Co. 675, 693, 707, 738
Union Sales Corp., feeds 675, 685
United Mills Co., Inc. 675
Upper Hudson Rye Flour Mills, Inc., feeds 675, 687
Urea 19, 23, 25
Vegetable breeding, summary of studies 760
insects 493
Vigoro 19, 84
Vinegar 808
Virginia-Carolina Chemical Corp., fertilizers 19, 20, 22, 25, 39, 43, 57, 63, 86
Vitality Mills, Inc. 675, 707, 738
Water 821
Watercress, vitamin distribution in 756
Wadsworth Feed Co. 675, 707
Wayne Feed Mills 676, 693, 708, 713, 738, 739
Wertz, F. S., and Son, feeds 676, 693
Wessel, Duval and Co., fertilizers 19
White pine blister rust, act prohibiting growing of black currants 516
appropriation xiii
appearance 461
control in Connecticut 463

PAGE

White pine blister rust, control future policy 470
measures for 459
nurseries quarantined 466
present status 466
damage, extent of 468
how to prevent 453
economic importance 455
insects and diseases mistaken for 471
history 456
life cycle 457
nature of 457
Ribes, effectiveness of eradication 468
prevalence in Connecticut 472
Wilcox Fertilizer Co. 19, 26, 27, 30, 39, 43, 44, 48, 55, 56, 57, 58, 63, 86
Willow scab fungus 757
Wolverton Flour Mills Co., Ltd. 676
Woodruff, S. D., & Sons, fertilizers 20, 93, 94
Worcester Rendering Co., feeds 676, 743
fertilizers 20, 88
Xylina antennata 492
Yantic Grain & Products Co., feeds 676, 683, 685, 693, 707, 711, 739
Zeuzera 503
pyrina 492

CIRCULARS 68 TO 72

Circular 68[1] January 15, 1930

THE EUROPEAN CORN BORER QUARANTINE AND CLEAN-UP REGULATIONS

W. E. BRITTON

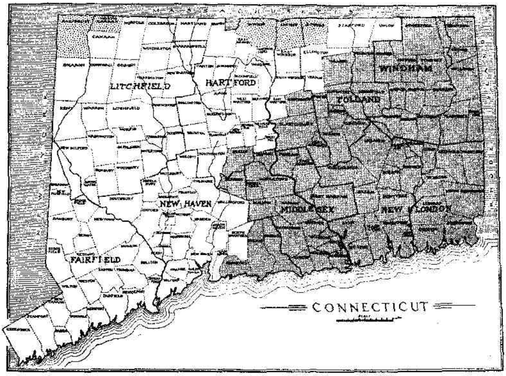

FIGURE 1. Map of Connecticut showing area under State and Federal quarantine on account of European corn borer. Shaded portion at right represents the two-generation area, and is part of the larger infestation extending over Rhode Island, eastern Massachusetts, New Hampshire and southeastern Maine. Lighter shaded portions in northwestern and north central part of the State represent the one-generation area, and are part of the large infestation of western Massachusetts, New York and westward.

Connecticut Agricultural Experiment Station

New Haven

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[1] This publication is a continuation of the series known as BULLETINS OF IMMEDIATE INFORMATION, which hereafter will be called CIRCULARS.

WHAT THE GROWER SHOULD KNOW

1. Infestation.—The European corn borer has spread over nearly half of Connecticut. Strict control methods must be practiced by the grower, or profit from corn growing will soon be impossible.

2. Quarantine.—The revised State and Federal orders include all of Middlesex, New London and Windham Counties and the following towns outside: Berlin, Glastonbury, Manchester, Marlborough, Branford, Guilford, Madison, Meriden, Andover, Bolton, Columbia, Coventry, Hebron, Mansfield, Tolland and Willington, all of which are in a generally infested region. The towns of Suffield, Enfield, Somers, North Canaan and Salisbury, which are not in the large area, are also under the restrictions. See the map on the cover.

3. Control law.—Destruction of stalks in the quarantined areas is required before April 10, under the provision of a Connecticut statute. The order by the director of the experiment station is that "all cornstalks shall be disposed of .... by feeding to livestock, burning or plowing under cleanly, and that all the larger weeds in and around the cornfields be likewise destroyed." *Violators are subject to fine.*

4. Shipment.—No corn on the ear may be shipped out of the restricted area and in the summer months all celery, green beans in the pod, beets with tops and rhubarb must be certified by inspectors.

5. Inspection service.—Those who have produce to be certified should apply to H. N. Bartley, Federal agent, 22 Elizabeth Street, South Norwalk, or to local agents soon to be announced.

THE EUROPEAN CORN BORER QUARANTINE AND CLEAN-UP REGULATIONS

The European corn borer, *Pyrausta nubilalis* Hubn., is a serious pest of corn, which also attacks certain vegetable and flowering plants. The insect is now present over nearly half the area of Connecticut and corn growers must soon practice cultural methods of control or they will be unable to grow corn at a profit. As new quarantine and control regulations have recently been established, this circular is published to give the latest regulations, but it also contains a brief account of the European corn borer and its injury.

This insect has a dirty white larva an inch or less in length, marked with scattered black dots. It prefers corn and it tunnels all through the stalks and ears. Breaking over of the tassels is one of the symptoms first noticed by the grower. When heavily infested, the entire stalks break down, and nearby celery, rhubarb, bean, beet, dahlia, chrysanthemum, gladiolus, aster, cosmos, zinnia, and other cultivated herbaceous plants and many of the larger weeds may be attacked.

In Connecticut, the heaviest infestations occur in the southeastern portion near the Rhode Island line.

COMPULSORY CONTROL

Owing to the recent rapid spread of the corn borer in Connecticut, it was foreseen that the cost of clean-up in such a large territory would be too great to be defrayed by public funds. Consequently it will be necessary for each grower to dispose of his own corn stalks and stubble. A certain proportion of growers will do this voluntarily for their own benefit, but others will not do so except under pressure. In order to make it possible to clean up all fields, the General Assembly of 1929 enacted the following law:

PUBLIC ACTS OF 1929

CHAPTER 171

AN ACT CONCERNING THE CONTROL OF THE EUROPEAN CORN BORER

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. The director of the Connecticut Agricultural Experiment Station shall issue and publish orders, rules and regulations which shall be effective in any town or portion thereof which shall have been quarantined on account of the European corn borer as provided by chapter 31 of the

public acts of 1927, which orders, rules and regulations may require that each owner, tenant or manager of land on which corn of any kind has been grown shall, not later than December first of the year of its growth, plow or cause to be plowed the field in which it was grown, so as to bury the stubble to a depth of at least six inches, or pull up and destroy such stubble or cause it to be pulled up and destroyed by burning, and each person having in his possession corn stalks shall, not later than April tenth of the year following that of their growth, completely dispose of such corn stalks by using them as fodder or by burning them, and shall destroy, or cause to be destroyed, on or before April tenth of each year, all weeds in such areas as may be designated by the director of the Connecticut Agricultural Experiment Station.

SEC. 2. Any person who shall violate any provision of this act or any order, rule or regulation issued by authority of any such provision shall be fined not more than one hundred dollars.

Approved June 3, 1929.

STATE OF CONNECTICUT
AGRICULTURAL EXPERIMENT STATION
NEW HAVEN, CONN.

CLEAN-UP ORDER

Pursuant to the provisions of Chapter 171, Public Acts of 1929, I, William L. Slate, Director of the Connecticut Agricultural Experiment Station, do hereby issue orders, rules and regulations as follows: That in the quarantined area all corn stalks shall be disposed of on or before April 10, by feeding to live stock, burning or plowing under cleanly, and that all of the larger weeds in and around the corn fields be likewise destroyed.

Effective January 15, 1930.

WILLIAM L. SLATE,
Director.

CULTURAL CONTROL METHODS

The following practices must be carried out by all growers if it is desired to hold the European corn borer in check. Otherwise, it may be impossible to grow corn at a profit after the State becomes thoroughly infested:

1. *Corn stalks should be cut* just as early as possible after maturity and put in the silo or fed out to cattle. When fed out, uneaten portions of stalks should be destroyed. If allowed to stand, such stalks furnish a favorable shelter for borers.

2. *If the stalk is cut close to the surface* of the ground, very few borers will be contained in the stubble. If it is cut 6-12 inches high, the stubble may furnish enough borers to ruin the crop the following year, and such stubble should be plowed under cleanly, or pulled and burned.

3. *Corn stalks which are not cut* and used for silage or fodder should be burned in the field or cleanly plowed under. The larger weeds in the fields and around the margins should also be burned.

4. *By clean plowing in the fall,* a large percentage of the second-brood borers are killed in the winter. Fall plowing is

somewhat less effective against the single-brooded borers, but against both one-generation and two-generation borers, early spring plowing (in April) is beneficial, especially if all debris is covered deeply. There are now plows and attachments to facilitate the clean plowing under of standing corn stalks, and your county agent can advise you regarding them.

5. *Small patches of sweet corn* in back yard gardens can perhaps be pulled and burned to best advantage. If not cleaned up, such places will produce enough borers to infest the entire countryside.

QUARANTINE

After due notice and a public hearing at the station January 7, 1930, the following quarantine order was issued, effective January 15, 1930. This is in accord with Federal Quarantine No. 43, as revised and effective December 16, 1929.

State of Connecticut
Agricultural Experiment Station
New Haven, Conn.

Quarantine Order No. 24

CONCERNING THE EUROPEAN CORN BORER

The fact has been determined that the European corn borer, *Pyrausta nubilalis* Hubn., has spread to such an extent as to make it necessary to extend the area restricted by State Quarantine Order No. 21, effective March 15, 1929, and likewise to bring it into conformity with Federal Quarantine No. 43, as revised, effective December 16, 1929. A public hearing was held at the Connecticut Agricultural Experiment Station, New Haven, on Tuesday, January 7, 1930, at 2 o'clock P. M., as provided in Chapter 31, Public Acts of 1927.

Now, therefore, I, William L. Slate, Director of the Connecticut Agricultural Experiment Station, under authority granted by Chapter 31, Public Acts of 1927, do hereby proclaim the following areas (including towns affected by Quarantine Order No. 21) to be under quarantine and subject to the restrictions and regulations made a part of Federal Quarantine No. 43, as revised and effective December 16, 1929.

Regulated Areas

Two-Generation area:—All towns, boroughs and cities in Middlesex, New London and Windham Counties; Berlin, Glastonbury, Manchester and Marlborough in Hartford County; Branford, Guilford, Madison and Meriden in New Haven County; Andover, Bolton, Columbia, Coventry, Hebron, Mansfield, Tolland and Willington in Tolland County.

One-Generation area:—The towns of Enfield and Suffield in Hartford County; Somers in Tolland County; North Canaan and Salisbury in Litchfield County.

Movement of Restricted Plants

Until further notice unless accompanied by a certificate or permit issued by an authorized inspector of the Connecticut Agricultural Experiment Station or Federal Plant Quarantine and Control Administration, the following plants and plant materials cannot be allowed movement from the restricted areas to points outside or from the two-generation area into the one-generation area or from the one-generation area into the two-generation area: corn, broom corn, sorghum and sudan grass, including all parts of leaves and stalks throughout the year; from the two-generation area, all cut flowers and entire plants of chrysanthemum, aster, cosmos, zinnia, hollyhock, gladiolus and dahlia (except gladiolus and dahlia bulbs without stems) throughout the year; for the period between June 1 and December 31, all celery, green beans in the pod, beets with tops, rhubarb, oat and rye straw as such or when used as packing.

Shelled corn must bear a certificate or permit that the corn is clean (except that packages of shelled corn weighing 25 pounds or less to the shipment may be sent without certificate or permit).

This order shall take effect January 15, 1930.

WILLIAM L. SLATE,
Director.

Approved:
JOHN H. TRUMBULL,
Governor.

SUMMARY OF REGULATIONS

For the guidance of growers and shippers, the regulations about moving crops from the quarantined area (see Figure 1) to the free area are given below:

Movement Not Allowed

Applies Throughout the Year: Corn on the ear, either green or dry, corn stalks, broom corn, sorghum and sudan grass, including all parts of leaves and stems. Inspections and permits refused.

Movement Allowed with Certificates

Applies Throughout the Year: From the two-generation area all cut flowers and entire plants of aster, chrysanthemum, cosmos, dahlia, gladiolus, hollyhock, and zinnia must be inspected and certified for shipment. (No restrictions on gladiolus and dahlia bulbs without stems.)

Applies from June 1 to December 31: All celery, green beans in the pod, beets with tops, rhubarb, oat and rye straw as such or when used as packing must be inspected and certified. (No restrictions from January 1-May 31).

Shelled Dry Corn: Quantities of 25 pounds or less without restrictions. Larger quantities must bear permit or certificate showing that corn is clean and free from pieces of cobs and stalks throughout the year.

For further information about the European corn borer apply to:

W. E. BRITTON, Connecticut Agricultural Experiment Station, New Haven, Conn. In charge of State regulatory work.

H. N. BARTLEY, 22 Elizabeth St., South Norwalk, Conn. In charge of Federal control work.

Requests for inspection and certification should be made to Mr. Bartley or to local inspectors soon to be announced.

Circular 69 May, 1930

Connecticut Agricultural Experiment Station

New Haven

EUROPEAN BLACK CURRANTS OUTLAWED

J. E. Riley, Jr.

CHAPTER 172 OF THE PUBLIC ACTS OF 1929

Section 1. Any person who shall grow, plant, propagate, cultivate, sell, transport or possess any plant, root or cutting of the European black currant, or Ribes nigrum, shall be fined not less than five dollars nor more than twenty-five dollars.

Sec. 2. The director of the Connecticut Agricultural Experiment Station is authorized to seize and destroy any plants, roots or cuttings of said European black currant found in the state.

The foregoing law became effective July 1, 1929. It was enacted for the purpose of protecting the white pines of Connecticut from the white pine blister rust, a fungous disease parasitic on white pines and all species of currants and gooseberries.

The European black currants, *Ribes nigrum* L., are especially susceptible to blister rust infection. They have been known to take infection at distances up to 100 miles or more from diseased pines. When infected, these currants can transmit the rust to trees a mile away. They act as the chief agent in the long distance spread and local establishment of the rust and are, therefore, a special menace to the white pines.

DESTRUCTIVENESS OF THE BLISTER RUST

The white pine blister rust has all the destructiveness of the chestnut blight, which has destroyed the chestnut. The rust accomplishes its results more slowly and is consequently less spectacular. Young white pine trees are quickly killed and soon disappear from the forest, thus preventing a natural perpetuation of the white pine as a forest crop. This destruction of white pine reproduction constitutes the most serious aspect of the blister rust menace and is the one least likely to be observed. Older trees when infected may live from five to twenty years or longer depending upon the number and location of the infections, but ultimately they are killed.

NATURE OF THE FUNGUS

The blister rust is not an insect nor a worm. It is one of the lowest forms of plant life and belongs to a group called fungi. Some fungi, like the molds found on jelly or bread, live on dead plant material. Other fungi, like the chestnut blight, exist on live plants and are called parasites. Certain parasites, such as the wheat rust and the white pine blister rust, require two host plants upon which to complete their life cycle. They belong to a group of parasitic fungi called rusts.

HOW THE DISEASE SPREADS

The rust spreads between white pines and currants and gooseberries by means of seed-like-bodies called spores. Three years or more after the rust attacks the white pine, it produces orange-yellow blisters on the infected bark, which, when broken, liberate the spores. These are carried by the wind long distances and on coming in contact with the under side of currant and gooseberry leaves under favorable atmospheric conditions they germinate. The rust then grows into the leaf and soon produces the typical rust spots on its under side. These spots produce the spores that spread the disease during the summer on currants and gooseberries. Later in the summer, this same fungous growth forms brown horn-like projections, visible on the underside of the leaves. These horn-like projections produce the spores that infect white pine in the fall.

The disease cannot spread directly from pine to pine. The fact that it must spend part of its life on currant or gooseberry plants makes it possible to control the disease by eradicating these plants in the vicinity of white pine.

HOW TO CONTROL THE RUST

As previously stated, spores from the European black currant may spread the rust to white pine a mile distant. Spores from other currants and gooseberries do not ordinarily spread the rust to pine more than 900 feet from the diseased bush. Therefore practical protection is given a stand of white pine by destroying all currants and gooseberries, both wild and cultivated, within 900 feet of the trees and the European black currants within one mile.

HOW TO TELL THE EUROPEAN BLACK CURRANT

The European and American black currants may be distinguished from all other cultivated currants by the amber-colored resin dots on the under side of the leaves. No other cultivated currant leaf

has them. The two cultivated black currants may be distinguished from each other as follows:

European Black Currant *Ribes nigrum*	American Black Currant *Ribes amercianum*
1. Resin dots on under side of leaves only.	1. Resin dots on both sides of leaves. A magnifying glass may sometimes be necessary to see them on the under surface.
2. Branches and twigs are round.	2. Branches and twigs are angular or ridged.
3. Leaves and stems have a strong, disagreeable, spicy odor when crushed.	3. Leaves and stems do not have strong, disagreeable odor when crushed.
4. Fruit smooth, black, pungent, somewhat musky.	4. Fruit smooth and black but not pungent or musky.
5. Flowers, greenish or whitish, saucer-shaped or open bell-shaped; racimes nodding, short, 5 to 10 flowers.	5. Flowers, greenish-white or yellowish, cylindrical-bell-shaped; racimes pendulous, many flowered.

REMEMBER

The cultivation of the European black currant within the State is prohibited by law and it is a misdemeanor to have it in your possession.

The State is now carrying on blister rust control through the removal of all currant and gooseberry plants within infecting distance of white pine. Your willing coöperation in the elimination of the European black currant will greatly assist in this work.

For further information on the white pine blister rust and its control, write the Forestry Department, Connecticut Agricultural Experiment Station, New Haven.

Circular 70 May, 1930

NURSERY SANITATION ZONES

White Pine Blister Rust Control

J. E. RILEY, JR.

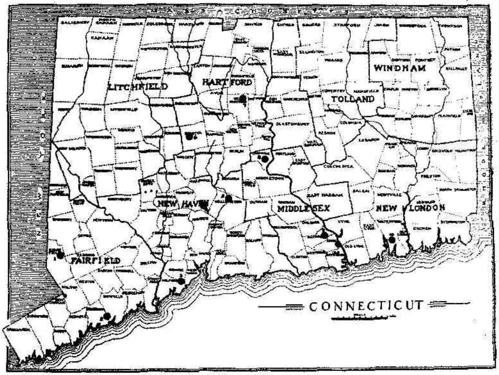

FIGURE 2. Map of Connecticut. Black dots indicate location of Nursery Sanitation Zones, within which no currants or gooseberries may be grown.

Connecticut Agricultural Experiment Station

New Haven

NURSERY SANITATION ZONES

White Pine Blister Rust Control

J. E. Riley, Jr.

At present there are no state or federal regulations requiring the nurseries that grow white pine to establish and maintain Sanitation Zones unless they wish to qualify for interstate shipment of white pines. The Connecticut Agricultural Experiment Station,

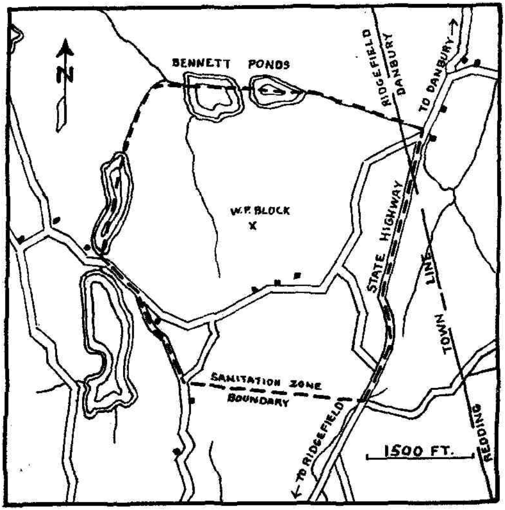

Figure 3. Map of sections of towns of Ridgefield, Danbury and Redding. Dotted line surrounds area within which no Ribes may be grown. Outpost Nurseries.

however, wishes to encourage the establishment of such zones around those nurseries doing an appreciable volume of white pine business, as a step in the control of the white pine blister

rust and as a protection to the nurseries themselves and to the purchasers of white pine ornamental and reforesting stock. The Forestry Department of the Station will coöperate with the nurserymen in the establishment of such zones and will assume full responsibility for their maintenance with the financial help of the coöperating nurseries.

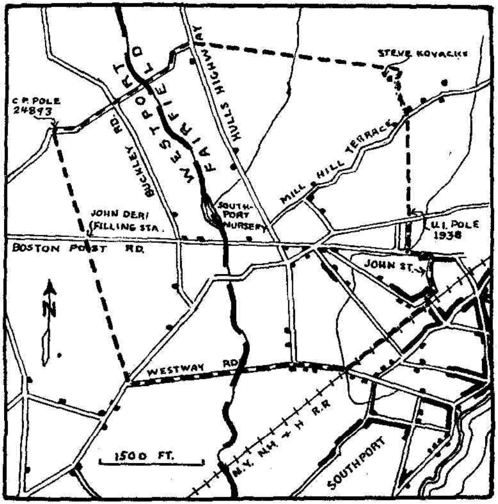

FIGURE 4. Map of sections of towns of Fairfield and Westport. Dotted line surrounds area within which no Ribes may be grown.

Ten nurseries have established such zones, the location of which are shown on the state map by black dots. The boundaries of these Sanitation Zones are indicated by the dotted lines on the section maps. No currant or gooseberry plants may be grown within these area

QUARANTINE ORDER

State of Connecticut
Agricultural Experiment Station
New Haven, Conn.

Quarantine Order No. 17

CONCERNING NURSERY SANITATION ZONES

In view of the fact that the white pine crop of the state is of great economic importance and because the present and future supply of this wood is menaced by the white pine blister rust, measures are being taken by the Connecticut Agricultural Experiment Station to control this disease. As one means of control, measures will be taken to prevent infection of white pine stock grown in commercial nurseries.

It has been demonstrated that the white pine blister rust spreads from pine to pine only through intermediate stages on currant and gooseberry leaves.

Now, herefore, I, Director of the Connecticut Agricultural Experiment Station, pursuant to the provisions of Chapter 31 of the Public Acts of 1927, after a public hearing of which due notice was given affected parties, do hereby proclaim quarantine areas surrounding the hereinafter named nurseries. Such quarantine areas shall each consist of two zones[1]; a zone extending approximately one mile from the nursery bounds within which no cultivated black currants, *Ribes nigrum,* may be grown or possessed and within which all present bushes of this species shall be destroyed or removed; a zone extending fifteen hundred feet from the bounds of the nursery, within which no cultivated currants or gooseberries of any species may be grown or possessed and within which all plants of the genus Ribes shall be destroyed or removed, an agreement having been made with the nurseries in question to compensate the owners of the above mentioned cultivated Ribes or to substitute plants of other species for those destroyed.

The exact boundaries of the zones shall be described and mapped and copies of same filed with the State Entomologist. Such quarantine areas surround the following nurseries[2]:

A. N. Pierson, Inc.	Cromwell, Conn.
Elm City Nursery	Woodmont, Conn.
H. J. Zack Co.	Deep River, Conn.
Southport Nursery	Southport, Conn.
North-Eastern Forestry Co.	Cheshire, Conn.
Outpost Nurseries	Ridgefield, Conn.
The Barnes Brothers Nursery Co.	Yalesville, Conn.
Verkade's Nursery	Waterford, Conn.
Sierman's Nursery	W. Hartford, Conn.

This quarantine order becomes effective October 1, 1928.

William L. Slate,
Director.

John H. Trumbull,
Governor.

[1] Since the placing of this quarantine a state law, quoted later in this bulletin, h[as] banned the European black currant throughout the State.

[2] *A sanitation zone is being established at the Bristol Nursery, Bristol, Conn., b[ut]* has not yet been officially declared.

THE WHITE PINE BLISTER RUST

The white pine blister rust, *Cronartium ribicola* Fisch, is a destructive fungus that lives part of its life on the leaves of currant and gooseberry plants and the rest of its life in the bark of white or five-needled pines. It reproduces itself by means of seed-like bodies called spores, which are carried by the wind from plant to plant. These spores are of three kinds. Those produced

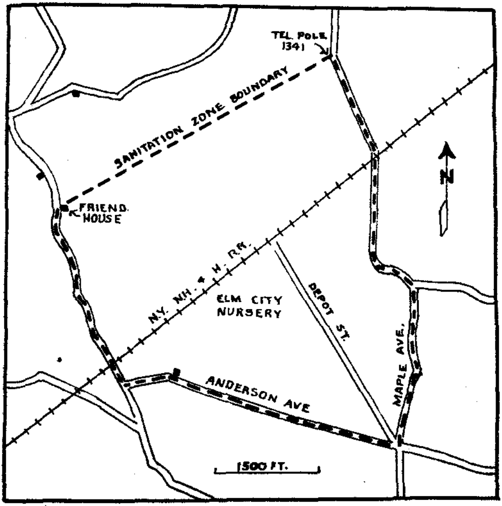

FIGURE 5. Map of sections of towns of Milford and Orange. Dotted line surrounds area within which no Ribes may be grown. Elm City Nursery.

in the orange-yellow blisters of diseased white pines carry the rust to leaves of currants and gooseberries in the spring and early summer. The spores from the rust-colored spots on the under side of infected currant and gooseberry leaves carry the disease during the summer to other currant and gooseberry leaves. From late June until the leaves drop in the fall the fungus develops brown, hair-like projections on the under side of the diseased

leaves. These outgrowths produce the spores that infect white pines, thus completing the life cycle of the fungus. The white pine blister rust cannot spread directly from tree to tree, therefore it may be controlled through the elimination of all currants and gooseberries within infecting distance of white pines.

History

The white pine blister rust is probably of Asiatic origin and has been known in Europe for many years. It has been in the United States since about 1898 and there is some evidence to indicate that it may have been introduced at Kittery Point, Maine,

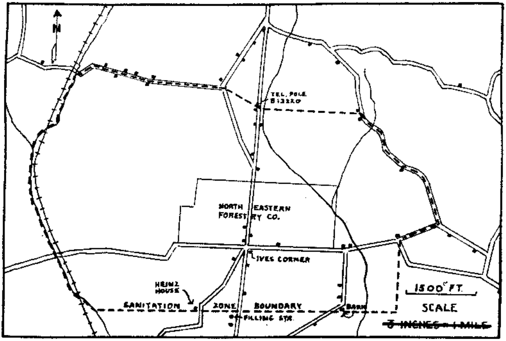

FIGURE 6. Map of section of town of Cheshire. Dotted line surrounds area within which no Ribes may be grown. North-Eastern Forestry Co.

on imported black currants. However, it was first recognized and reported on cultivated black currants at Geneva, N. Y., in 1906. The rust was brought into this country and widely distributed throughout New England and New York on white pine nursery stock before the enactment of the Federal Quarantine Act in 1912. The Connecticut Agricultural Experiment Station identified it on some imported nursery stock being planted at Wilton, Conn., in 1909.

Distribution

The rust is now present in New England, New York, Pennsylvania, New Jersey, Michigan, Minnesota, Wisconsin, Washington, Oregon, Idaho and Montana. In Connecticut it can be found

generally distributed on Ribes throughout the state. It is very common on white pines in northern Litchfield county; it is more or less prevalent on pines throughout the natural white pine sections of northern Connecticut, and is occasionally found on pines in the rest of the state.

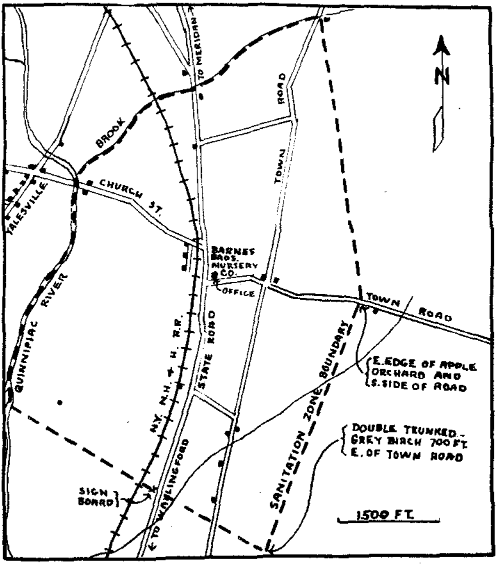

FIGURE 7. Map of section of town of Wallingford. Dotted line surrounds area within which no Ribes may be grown. Barnes Brothers Nursery Co.

Destructive Possibilities

The white pine blister rust has all the destructive potentialities of the chestnut blight, although it accomplishes its results more slowly and consequently less spectacularly. White pine is one of Connecticut's most valuable forest tree species and one highly

valued for ornamental purposes. The insurance, therefore, of disease free nursery stock is of economic importance that far outweighs the commercial importance of currants and gooseberries.

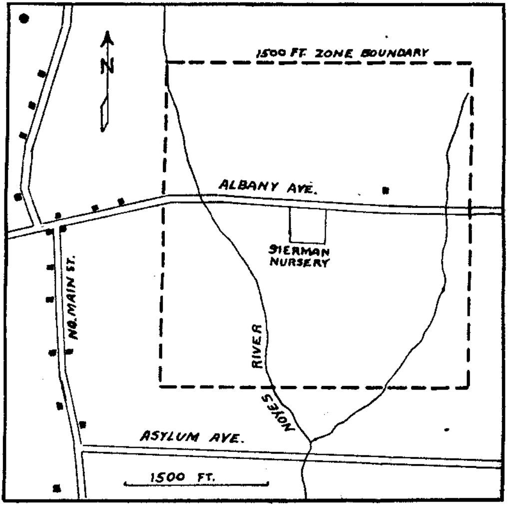

FIGURE 8. Map of town of West Hartford. Dotted line surrounds area within which no Ribes may be grown. Sierman's Nursery.

REGULATIONS

The interstate movement of white pines and of currant and gooseberry plants is prohibited by Federal Quarantine 63,[1] except in compliance with its very stringent regulations.

[1] A copy of this quarantine order may be obtained from the Plant Federal Quarantine and Control Administration, United States Department of Agriculture, Washington, D. C. A digest of those parts of the order that apply to shipments from Connecticut is being prepared and may be had by writing to the State Agricultural Experiment Station, New Haven.

State regulations make the distribution within Connecticut, of Connecticut nursery grown white pine stock, legal only under permit from the State Nursery Inspector. Nursery stock showing a serious disease, such as the white pine blister rust, is destroyed. This inspection, however, does not in itself guarantee

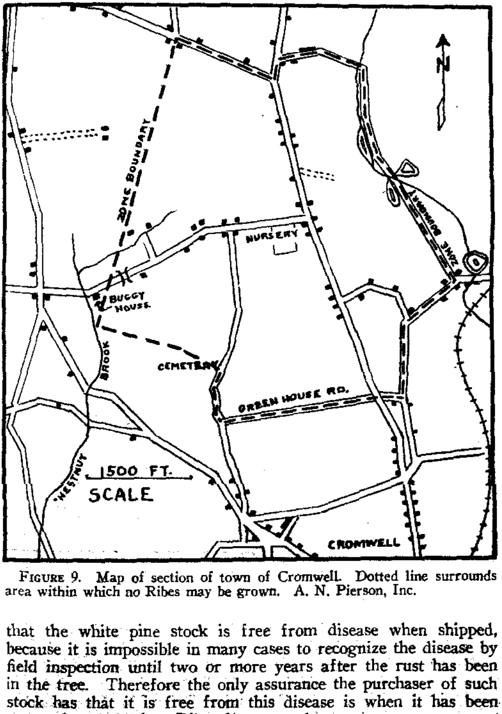

FIGURE 9. Map of section of town of Cromwell. Dotted line surrounds area within which no Ribes may be grown. A. N. Pierson, Inc.

that the white pine stock is free from disease when shipped, because it is impossible in many cases to recognize the disease by field inspection until two or more years after the rust has been in the tree. Therefore the only assurance the purchaser of such stock has that it is free from this disease is when it has been grown from seed in a Ribes-free control area.

In view of the facts that infection on pine may take place over a distance of one mile from diseased European black currants, *Ribes nigrum,* and 900 feet, under rare conditions possibly over greater distances, from other Ribes, the control area or sanitation zone must extend 1,500 feet from the block in which the white

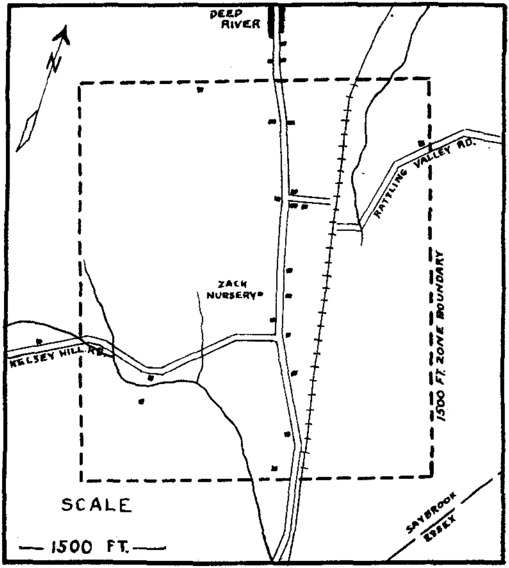

FIGURE 10. Map of section of town of Saybrook. Dotted line surrounds area within which no Ribes may be grown. H. J. Zack Co.

pine is grown. Compliance with the mile zone requirement that pertains to the elimination of European black currants in the vicinity should offer no difficulties, owing to the fact that the state law completely prohibits the harboring of this species anywhere in the state. State Quarantine Order No. 17 establishes such zones around certain coöperating nurseries. Future quaran-

tine orders may establish additional zones at other nurseries that wish to coöperate with the Station in this matter.

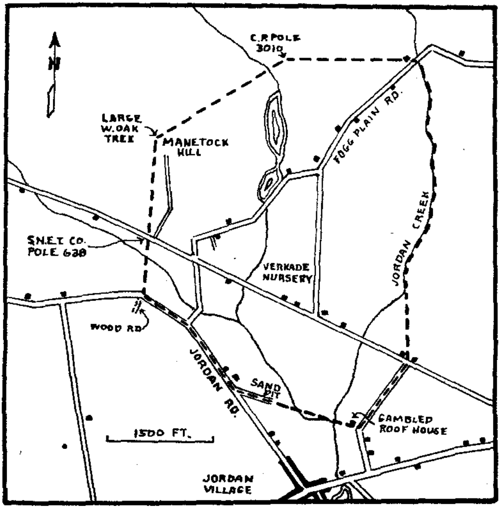

FIGURE 11. Map of section of town of Waterford. Dotted line surrounds area within which no Ribes may be grown. Verkade's Nursery.

EUROPEAN BLACK CURRANTS BANNED

On July 1, 1929, a European black currant law became effective outlawing this species of currant in Connecticut. It will be found in Chapter 172 of the Public Acts of 1929. The text is as follows:

SECTION 1. Any person who shall grow, plant, propagate, cultivate, sell, transport, or possess any plant, root or cutting of the European black currant, or *Ribes nigrum,* shall be fined not less than five dollars nor more than twenty-five dollars.

SEC. 2. The Director of the Connecticut Agricultural Experiment Station is authorized to seize and destroy any plants, roots or cuttings of said European black currant found in the state.

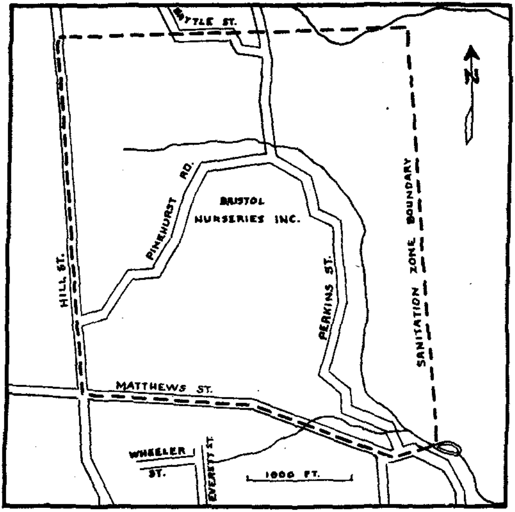

FIGURE 12. Map of section of town of Bristol. Dotted line surrounds area within which no Ribes may be grown. Bristol Nursery.

For information not given in this leaflet concerning the white pine blister rust and its control or the coöperative establishment of Nursery Sanitation Zones, write to:

W. O. FILLEY, Forester, Connecticut Agricultural Experiment Station, 125 Huntington Street, New Haven, Conn.

For information as to quarantines, nursery inspections, and shipping permits, consult:

W. E. BRITTON, State Entomologist, Connecticut Agricultural Experiment Station, 125 Huntington Street, New Haven, Conn.

Circular 71 July 15, 1930

Connecticut Agricultural Experiment Station

New Haven

REGULATIONS CONCERNING THE TRANSPORTATION OF NURSERY STOCK IN THE UNITED STATES AND CANADA

Compiled by W. E. Britton, State Entomologist

At the present time nearly every State in the Union has laws or regulations in regard to the inspection, certification and transportation of nursery stock. These all have one object in view, namely, the control of plant pests. But conditions are not uniform throughout the United States, and each State has established such requirements as seem to give it the best protection, with the result that there are many different regulations.

This situation assumes a serious aspect to the nurserymen who may wish to fill orders received from eighteen or twenty or more different States. In order to tabulate and bring together these varying regulations in convenient form for the use of Connecticut nurserymen, this bulletin has been prepared. It should be understood that it presents only a brief digest in each case, and if any points are not clear, the nurseryman should write to the officer in charge of inspection in that State for more information.

In addition to the various State laws and regulations, there are several Federal quarantines regulating the shipment of nursery stock. A digest of these has been included in this bulletin, together with the regulations of the District of Columbia and of the Dominion of Canada.

FEDERAL QUARANTINES

The following Federal quarantines concern the shipment of nursery stock:

White pine blister rust. Quarantine No. 63 regulates the interstate movement throughout the United States of five-leafed

Note—Third revision of Bulletin of Immediate Information 51, October 1, 1925.

pines and currant and gooseberry plants. However, the following comments relate only to the application of the regulations to the New England States and New York. Shippers in other States should consult the quarantine for full information as to restrictions applying to such States.

Five-leafed pines may not be moved interstate from the area composed of the New England States and New York except that movement to the States of New Jersey, Pennsylvania, Wisconsin, Michigan and Minnesota may be authorized of pines grown from seed under Federal permit in accordance with certain specified conditions as to Ribes-free environs and freedom from white pine blister rust. Such shipments must be accompanied by Federal permit and comply also with Regulation 2 (a).

Five-leafed pines may be shipped from one State to another *within* the area composed of the New England States and New York on compliance with Regulation 2 (a) requiring that each container is plainly marked to show the names and addresses of the consignor and of the consignee, and has attached to the outside thereof a valid State nursery inspection certificate of the State from which the shipment is made. Shipments may not be made into any State having a legally established control area unless a control-area permit shall have been issued therefor by an inspector designated to act for the Plant Quarantine and Control Administration in such State, and each container of such pines shall bear such permit affixed on the outside thereof. With the exception of Vermont, all the New England States, New York, Michigan and Idaho, have established control areas. Applications for permit should be made to the State officials whose names appear on later pages at the close of the abstract of regulations of the State concerned.

All currant and gooseberry plants other than cultivated red and white and mountain currants and cultivated gooseberry plants are prohibited movement out of Connecticut or any other State designated as infected with white pine blister rust. Cultivated red and white and mountain currants and cultivated gooseberry plants may be shipped out of the infected States on compliance with Regulation 4 requiring—

(1) That the container is plainly marked to show the names and addresses of the consignor and of the consignee and has attached to the outside a valid State nursery inspection certificate of the State from which the shipment is made.

(2) That each such shipment moved interstate into any State having a legally established blister-rust control area shall bear on the outside of the container a control-area permit (Form 415) issued by an inspector designated to act for the Plant Quarantine and Control Administration in such State. (For list of such States see previous paragraph.)

(3) That the plants may be shipped only during the period from September 20 to May 15.

(4) "That if shipped in the fall, the said plants are defoliated, (*i.e.*, without leaves); and, if shipped in the spring, they are free from leaves of the previous season's growth: *Provided*, that if shipped in the spring after April 15, the said plants shall be completely dormant.

(5) "That, before shipment they have been completely immersed (except the roots) in a solution consisting of one part of concentrated lime-sulfur solution testing not less than 32° Baume to eight parts of water by volume, the dilute solution to test not less than 4.5° Baume. Such lime-sulfur dip shall be plainly visible on said plants and be easily detectable by odor, the judgment of the inspector to be final as to adequacy of the dip and as to the condition of the plants as to dormancy and defoliation.

(6) "That the container shall be plainly marked to show that currant and gooseberry plants are contained therein."

Narcissus bulbs. Quarantine No. 62 provides that all varieties of narcissus bulbs may be shipped interstate only after inspection (and treatment if found infested) and certification in the State where grown. Each crate, box, or other container must bear a Federal shipping certificate authorizing interstate movement and such certificate shall remain and continue as a condition of any reshipment of such bulbs in original containers. "Certified narcissus bulbs taken from crates or other original containers for reshipment interstate in smaller lots shall have securely attached to each container a tag or label signed by the shipper thereof reading as follows: 'The undersigned certifies that the narcissus bulbs contained herein were taken from a shipment of narcissus bulbs certified by the Plant Quarantine and Control Administration under Notice of Quarantine No. 62.'"

Black stem rust of grains. Quarantine No. 38, as amended, prohibits the movement from Connecticut of the common barberry and its horticultural varieties (not including the Japanese barberry) and certain other species of Berberis and Mahonia to any of the following States: Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin and Wyoming.

European corn borer. Quarantine No. 43 (sixth revision) prohibits, except as provided in the rules and regulations supplemental thereto, the interstate movement of host plants of the borer (which include some herbaceous perennials) from the two-generation area including parts of Connecticut, Maine, Massachusetts, New Hampshire, the entire State of Rhode Island, and Fisher's Island, N. Y.

Gipsy moth and brown-tail moth. Quarantine No. 45 regulates the interstate shipment of all nursery stock, forest products,

stone and quarry products from the infested area in the New England States, and from the generally infested to the lightly infested areas within those States. Nursery stock must be inspected and certified by Federal inspectors.

Japanese beetle. Quarantine No. 48 (revised) regulates the interstate movement of all nursery stock and other materials from the regulated areas to or through outside points or from the generally infested to the lightly infested areas. The regulated areas include the States of New Jersey and Connecticut, the District of Columbia, and certain parts of Massachusetts, New York, Delaware, Pennsylvania, Maryland and Virginia. Nursery stock must be inspected and certified by Federal inspectors.

Satin moth. Quarantine No. 53, as revised, prohibits the interstate shipment from the infested areas in Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, Connecticut and Washington to outside points, of all species and varieties of willow and poplar trees or parts thereof capable of propagation.

Woodgate rust. Quarantine No. 65 prohibits the interstate movement from the regulated area in the State of New York of trees, branches, limbs, or twigs of Scotch pine, Canary Island pine, slash pine, Japanese red pine, Corsican pine, stone pine, western yellow pine, Monterey pine, loblolly pine, or Jersey pine, or of any variety thereof, or of any species or variety of hard pine hereafter found to be susceptible to the Woodgate rust.

Mediterranean fruit fly. The regulations supplemental to Quarantine No. 68, as at present, June, 1930, in effect, prohibit, except as provided therein, the reshipment or transportation from the noninfested States, including Connecticut, of Florida host fruits and vegetables, and railway cars and other vehicles and containers that have originated in and been moved from Florida or any other State that may hereafter be found infested.

For further information regarding Federal quarantines and regulations address: PLANT QUARANTINE AND CONTROL ADMINISTRATION, *U. S. Department of Agriculture, Washington, D. C.*

DISTRICT OF COLUMBIA

* Each package of nursery stock (including herbaceous plants and bulbs but not including cut flowers or seeds, except foreign-grown tree seeds) entering the District must bear a valid certificate of inspection, must be marked "plants," with name and address of both consignor and consignee. No package shall be delivered to the consignee until authorized by the inspector of the Plant Quarantine and Control Administration.

PLANT QUARANTINE AND CONTROL ADMINISTRATION, Washington, D. C.

DOMINION OF CANADA

Nursery stock and all plants for ornamental purposes, propagation or cropping, from the United States, can enter Canada only after permits (and official labels, if to be sent by mail) have been procured from the Secretary, Destructive Insect and Pest Act Advisory Board, Ottawa, Canada. Applications must specify quantity, kind, value, origin and destination of stock, name and address of consignor, consignee, the customs port, and whether to be shipped by mail, express, or freight. The importer will furnish the permit number to the shipper, and this number must be on every container, together with certificate of inspection issued at time of packing, original to accompany way-bill with copy on containers, and signed by an authorized official of the state or country where the stock originated, and the name and address of both consignor and consignee, and a declaration of kind and quantity of the stock. The following are designated as ports of importation:

Halifax, N. S.	Windsor, Ont.
Saint John, N. B.	Winnipeg, Man.
Montreal, Que.	Estevan, Sask.
Niagara Falls, Ont.	Vancouver, B. C.
Ottawa, Ont.	

Mail shipments may enter the ports named above and also Toronto, Ont.

Quarantines prohibit the entrance of conifers from New England; all five-leafed pines; all chestnut (*Castanea dentata*), and chinquapin (*Castanea pumila*), including hybrids and horticultural varieties; all currants and gooseberries, except commercial varieties of gooseberries, red and white currants cultivated for their edible fruits only; European buckthorn and all varieties of rust barberry (*Berberis vulgaris*); all varieties of Corylus into British Columbia from the States of Montana, Wyoming, Colorado, New Mexico, and all other states eastward; all peach nursery stock into British Columbia from Wisconsin, Illinois, Missouri, Arkansas, Texas, and all other states eastward to the Atlantic Ocean.

L. S. McLaine, *Secretary, Destructive Insect and Pest Act Advisory Board,* Department of Agriculture, Ottawa, Canada.

POSTAL REGULATIONS REGARDING NURSERY STOCK SHIPPED BY PARCEL POST

The United States Postal Laws and Regulations, Section 467, paragraph 2, governing the mailing of plants and plant products, reads as follows:

"Nursery stock, including all field-grown florists' stock, trees, shrubs, vines, cuttings, grafts, scions, buds, fruit pits and other seeds of fruit and ornamental trees or shrubs, and other plants and plant products for propagation, except field, vegetable and flower seeds, bedding plants and other

herbaceous plants, bulbs and roots, may be admitted to the mails only when accompanied with a certificate from a State or Government inspector to the effect that the nursery or premises from which such nursery stock is shipped has been inspected within a year and found free from injurious insects, and plant diseases, and the parcel containing such nursery stock is plainly marked to show the nature of the contents and the name and address of the sender."

STATE REGULATIONS

Filing of Certificates in Other States

In order to ship nursery stock into the following States, it is necessary to file duplicate inspection certificates:

Alabama	Maryland	Ohio
Arkansas	Massachusetts	Oklahoma
Connecticut	Michigan	Pennsylvania
Florida	Minnesota	South Carolina
Georgia	Mississippi	South Dakota
Idaho	Missouri	Tennessee
Illinois	Nebraska	Texas
Indiana	New Mexico	Utah
Iowa	New York	Virginia
Kentucky	North Carolina	Wisconsin
Louisiana	North Dakota	Wyoming

Filing of Bonds

Bonds are required in the following States:

Arkansas	$1,000.00	Montana	$1,000.00
Georgia	1,000.00	Oklahoma	1,000.00
Idaho	5,000.00	Utah	500.00

Tennessee requires a bond of $5,000 where trees are planted by outside nurserymen under contract to prune and spray for a period of years.

Payment of Fees

The payment of fees is required for registration in certain States, as follows:

State	Registration fee	Agent's fee	State	Registration fee	Agent's fee
Alabama	$10.00	$1.00	New Mexico	$5.00	
	(Dealers)—10.00		Ohio	5.00	$1.00
Arkansas	5.00	1.00	Oklahoma	5.00	
Georgia	5.00	1.00	Oregon	15.00	1.00
Idaho	10.00	1.00	South Dakota	1.00	1.00
Indiana	1.00	1.00	Texas	5.00	
Kentucky	5.00	5.00	Virginia	10.00	1.00
Maine	5.00		Washington	5.00	1.00
Michigan	5.00			(Dealers)—15.00	
Missouri	5.00		West Virginia	20.00	
Montana	25.00[1]		Wyoming	15.00	
Nebraska		1.00			

[1] Covering all Montana agents. Agents for unlicensed nurseries must pay annual fee of $10 and file bond of $1,000. Inspection fees, $10 per car lot, smaller lots in proportion. Unlicensed nurseries, 10 per cent of invoice price, with minimum of 50 cents per package.

Fumigation

All deciduous nursery stock subject to the attack of San José scale must be fumigated with hydrocyanic acid gas and labeled with a certificate or affidavit stating that this has been done, before it will be allowed to enter the following States:

Florida[1]	Mississippi	Tennessee
Maryland	South Carolina	Utah
Michigan[1]		

State Tags

State tags are required and will be furnished at the shippers' expense, by the following States:

Alabama	New Mexico	Virginia
Arkansas	North Carolina	West Virginia
Florida	South Carolina	Wisconsin
Louisiana	Texas[2]	Wyoming
Mississippi		

Special Inspection and Certification of Raspberry Plants

In an attempt to control mosaic and allied diseases of raspberry plants, certain states require two summer inspections: one in June, and the other a month later, and after all mosaic plants discovered at the first inspection have been removed. If the plants are then free from mosaic diseases, a certificate to that effect may be granted. The following states require this special inspection and certification for shipping raspberry plants:

Kansas	Minnesota	Vermont
Michigan	New York	Wisconsin

Requirements of Various States

Alabama. Nurserymen in other States wishing to ship stock into Alabama must obtain an Alabama license by filing a signed copy of inspection certificate, with fee of $10. Each package of nursery stock entering the State must bear an Alabama tag, which is furnished at cost. Dealers must register, file list of all nurseries from which they purchase stock, pay fee of $10 and obtain

[1] Fumigate all host plants of San José scale with hydrocyanic acid gas, at the standard dosage, or thoroughly scrub in a solution of fish oil soap at a dilution of one pound of soap to three gallons of water immediately before shipment into Florida. Such stock entering Michigan must bear certificate of fumigation.

[2] Texas requires tags showing an exact copy of the Texas permit but the shipper must have them printed from the original certificate.

a dealer's certificate. An agent's certificate (cost $1.00) must be obtained through the principal for each agent selling nursery stock in Alabama. Nursery stock infested with San José scale, new peach scale, woolly aphis, brown-tail moth, gipsy moth, crown gall, black knot, citrus canker, peach yellows, pear blight, apple blotch, root nematode, peach borer, grape phylloxera or nut grass, must not be sold in Alabama.

B. P. LIVINGSTON, *Chief, Division of Plant Industry,* Montgomery, Ala.

Arizona. All nursery stock and plant products entering Arizona through the United States mails or transported in any manner shall be prominently labeled, showing (a) name and address of consignor; (b) name and address of consignee; (c) certificate of inspection; (d) locality where grown, and (e) contents of shipment. Common carriers shall not deliver to consignee any shipment of nursery stock or plant products until inspected by the State Entomologist or his agent and a certificate of release issued in each case to the common carrier and to the consignee. Postmasters are required to forward all parcels of nursery stock or plant products to the nearest Post Office Inspection Station, and cannot forward from these stations to point of destination any parcel of nursery stock or plant products unless accompanied by an inspected plant shipment tag.

Quarantines prohibit the entrance of: Olive nursery stock and olive root cuttings from all other States and foreign countries; peach, nectarine or apricot trees or cuttings, grafts, scions, buds or pits, or trees budded or grafted upon peach stock from Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, Ohio, Indiana, Michigan, Illinois, West Virginia, Tennessee, North Carolina, Arkansas, Nevada, Florida, Mississippi, Kentucky, and Ontario, Can., and any other section in which peach yellows or rosette are known to exist; peach, nectarine, almond, apricot, plum, cherry, chokecherry, quince, pear, and apple trees or plants or parts thereof including the fresh fruits, and all barrels, boxes, baskets or other containers that have been used to hold the same from the States of Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Indiana, Louisiana, Maryland, Mississippi, North Carolina, New Jersey, New York, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, and the District of Columbia on account of the Oriental fruit moth; pecan, hickory and Japanese walnut trees, cuttings, grafts, scions and buds from all outside sources, with the exception of California, on account of the pecan leaf case-bearer.

O. C. BARTLETT, *State Entomologist,* Box 1857, Phoenix, Ariz.

Arkansas. In order to ship nursery stock into Arkansas, it is necessary (1) to file a nursery inspection certificate, pay a fee of $1.00 and secure a permit-certificate, and (2) every shipment into the State must bear a copy of the permit-certificate with the chief inspector's facsimile signature, and tags must be purchased of the chief inspector.

Out-of-state nurserymen having agents or representatives soliciting orders, or doing other nursery business in Arkansas, must (1) file a bond of $1,000, (2) pay $5.00 for a license to do business in the State, and (3) pay $1.00 for a license for each agent in the State.

Quarantines prohibit entrance of chestnut trees from all States east of the Mississippi River, Iowa and Nebraska.

P. H. MILLAR, *Chief Inspector,* Little Rock, Ark.

California. All shipments of nursery stock, plants, seeds, etc., made into the State of California must be marked in a conspicuous manner and place with the name and address of the shipper, the name and address of the consignee, and a statement of the contents of each package; also the name of the country, state, or territory where the contents were grown.

Of several state quarantines, the following are of interest to shippers to California:

Quarantine Order No. 1 (new series) prohibits the entry into California of citrus fruits, all varieties and species of citrus plants and parts thereof, including buds and scions.

Quarantine Order No. 2 (new series) prohibits the entry into California of all chestnut and chinquapin trees, plants, grafts, cuttings, or scions thereof from all states and districts east of and including the States of Montana, Wyoming, Colorado, and New Mexico, on account of chestnut bark disease.

Quarantine Order No. 3 (new series) prohibits the entry into California of all varieties and species, including the flowering forms of peach, nectarine, almond, apricot, plum, cherry, choke-cherry, quince, pear, and apple trees and plants, and fresh fruits thereof, from the States of New York, Connecticut, New Jersey, Ohio, Pennsylvania, Maryland, Delaware, Kentucky, West Virginia, Virginia, Tennessee, North Carolina, South Carolina, Florida, Georgia, Alabama, Mississippi, Louisiana, Arkansas, Texas, Indiana, Illinois and the District of Columbia; also States of Massachusetts, Michigan, Rhode Island, and Province of Ontario, Canada, on account of the Oriental fruit moth.

Quarantine Order No. 4 (new series) prohibits the entry into California of all trees, plants, grafts, cuttings, or scions of all species and varieties of the cultivated filbert or hazelnut and American wild hazel (*Corylus americana*) from all states and dis-

tricts east of and including the States of Montana, Wyoming, Colorado, and New Mexico, on account of Eastern filbert blight.

Quarantine Order No. 12 (new series) prohibits the entry into California of all varieties and species of hickory, pecan, and walnut trees (Hicoria sp. and Juglans sp.) and parts thereof, including grafts, cuttings or scions from all states east of and including the States of Montana, Wyoming, Colorado, and New Mexico, on account of the pecan leaf case bearer and the pecan nut case bearer.

Quarantine Order No. 14 (new series) prohibits the entry into California of all hop sets, hop roots, and hop cuttings from all States in the United States except the State of Oregon.

Quarantine Circular No. 1 (new series) prohibits the entry into California of peach, nectarine, or apricot trees or cuttings, grafts, scions, buds, or pits of such trees; or any trees budded or grafted upon peach stock or roots that have been in a district where the disease known as contagious peach rosette is known to exist. The States known to be infected are as follows: Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Delaware, Maryland, Pennsylvania, West Virginia, Virginia, North Carolina, Tennessee, Kentucky, Mississippi, Ohio, Michigan, Indiana, Arkansas, Florida, South Carolina, Georgia, Alabama, Oklahoma, District of Columbia, and the Province of Ontario in Canada.

Quarantine Circular No. 6 (new series) provides that grapevines or cuttings will be admitted if free from Phylloxera, subject to hot water treatment upon arrival.

A. C. FLEURY, *Senior Quarantine Supervisor,* Sacramento, Cal.

Colorado. Each package of nursery stock entering the State must bear a certificate of inspection signed by a duly authorized inspector in the State from which it was shipped. On arrival, shipments are turned over to the County Inspector, who, in turn, if they pass inspection, releases them to the consignee.

Quarantiues prohibit the entrance of the common barberry.

C. P. GILLETTE, *State Entomologist,* Fort Collins, Colo.

Connecticut. Nurseries are inspected annually and nurserymen and dealers must register; nurserymen receive registration and inspection certificates, and dealers receive permits. Out-of-state nurserymen must make application and file signed copies of their valid inspection certificates and receive permits before shipping stock into the State. All stock entering the State must he accompanied by both certificate and permit, and all stock transported within the State must be accompanied by either a certificate or by a permit, and transportation companies are subject to prosecution for accepting shipments without valid certificates or permits. Nursery stock imported from foreign countries must be held unopened until inspector arrives. Inspectors have authority to inspect any stock at destination.

Quarantines regulate the shipment of all nursery stock and forest products, on account of the gipsy moth, satin moth, Japanese beetle, and European corn borer.

W. E. BRITTON, *State Entomologist,* New Haven, Conn.

Delaware. Each shipment of nursery stock entering the State must be accompanied by a copy of the nursery inspection certificate, and all stock must conform to the Federal rules and regulations.

RALPH C. WILSON, *Secretary,* State Board of Agriculture, Dover, Del.

Florida. Each nurseryman shall (1) file with the Nursery Inspector, Gainesville, Fla., a copy of his certificate of inspection, personally signed by the proper official of his State, and make application for permit tags on a form supplied by the Nursery Inspector; (2) secure Florida permit tags (price list furnished); (3) attach one, and only one, Florida permit tag to each package, box or bundle of nursery stock[1] shipped into Florida. In club orders, one permit tag should be attached to each individual order, and one permit tag attached to the package containing the individual orders; (4) each permit tag is serially numbered. An invoice showing the name and address of consignor, name and address of consignee, kind and amount of nursery stock in the shipment and number of the permit tag attached to the shipment should be mailed the Nursery Inspector, Gainesville, on the day the shipment is made. An invoice is required for each individual order in a club order and also for the package containing the individual orders; (5) return all spoiled or mutilated permit tags to the Nursery Inspector for cancellation; (6) return all unused permit tags when the same become void; (7) fumigate all host plants of San José scale with hydrocyanic acid gas, at the standard dosage, or thoroughly scrub in a solution of fish oil soap at a dilution of one pound of soap to three gallons of water, immediately before shipment into Florida. (8) Plants showing root knot, hairy root, crown gall, or any especially injurious insect or disease will not be permitted entry into the State of Florida. (9) All citrus trees and parts thereof are prohibited entry into the State of Florida from all other states and countries.

NURSERY INSPECTOR, State Plant Board, Gainesville, Fla.

Georgia. Each nurseryman, dealer, agent, salesman or solicitor must apply to the State Board of Entomology, giving (1) the name and location of the nursery, and (2) the approximate acreage

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[1] **Strawberry plants, palms and woody perennials. Soft bodied herbaceous plants are not classed as nursery stock.**

and kinds of stock grown, and receive from the Board a license; annual fee for nurserymen and dealers is $5.00; annual fee for each agent, salesman or solicitor, $1.00. Where a sale amounts to $100 or more, a duplicate of the complete invoice (without price) must be filed with the State Board of Entomology, within 30 days of shipment, with the name and address of the salesman and of the purchaser, and name and quality of all nursery stock sold in the State or for delivery in the State.

All nurserymen, corporations, firms or individuals selling or offering to sell nursery stock in Georgia must file with the Board of Entomology, and maintain for three years, a bond of $1,000 made out to the Secretary of the Georgia State Board of Entomology.

Quarantines prohibit shipment into the State of all five-leafed pines, currants and gooseberries and all nursery stock from sections of states where Japanese camphor scale is present. Shipments of plants from areas infested by the Japanese beetle, European corn borer, gipsy moth and brown-tail moth are admitted only in strict accordance with the requirements of the Federal quarantine.

M. S. YEOMANS, *State Entomologist,* State Board of Entomology, Atlanta, Ga.

Idaho. No person, firm or corporation shall import or sell nursery stock by agents within the State without first applying to the Department of Agriculture, filing a bond for $5,000 and obtaining an annual license by paying a fee of $10. All shipments into the State must show name of shipper, locality where grown, variety of nursery stock and an official certificate of fumigation from the State where the stock was grown. Imported trees are fumigated before distribution, and all nursery stock shipped into the State must be inspected upon arrival at the expense of the consignee. Each nursery firm doing business in the State must annually pay an additional $1.00 for each agent. Duplicate certificates should be filed.

State quarantines exclude the entrance of all five-leafed pine, currant, gooseberry, peach, nectarine, prune, almond or other trees worked on peach stock and all pits, cuttings, buds or scions grown in a district where peach yellows or other detrimental diseases exist.

Permits for entry must be secured from the Bureau of Plant Industry and accompany the shipment before any currants or gooseberries can be shipped into the State. The eight northern counties are designated as a blister rust control area from which currants, gooseberries and five-leafed pines are excluded.

M. L. DEAN, *Director, Bureau of Plant Industry.* Boise. Idaho.

Illinois. Outside nurserymen and dealers in nursery stock wishing to ship nursery stock into Illinois or to solicit business in Illinois, are required to send to the Chief Plant Inspector a duplicate copy of their certificate of inspection signed in ink by their state inspector. Those employing agents are required to apply to the Chief Plant Inspector for a permit to employ agents in Illinois and for a permit for each agent as soon as he is employed. Agent's permits are renewable annually after July 1.

All nursery stock entering the State must bear a valid State or Federal certificate of inspection, the names and addresses of the consignor and the consignee, and a statement of the nature of the stock.

If stock arrives without certificate it must be destroyed or held by the transportation company until released or inspected by the Department of Agriculture and all expenses incurred by such inspection have been paid.

A State quarantine prohibits shipment of all species and varieties of the genus Castanea from the New England States, Alabama, Delaware, Georgia, Kentucky, Maryland, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia and West Virginia into Illinois.

Stock shipped into Illinois in violation of a State or a Federal quarantine is destroyed or returned to the consignor or otherwise disposed of at the discretion of the department.

P. A. GLENN, *Chief Plant Inspector,* Division of Plant Industry, Urbana, Ill.

Indiana. Nursery stock entering or shipped within the State must bear an official inspection certificate and give the names of both the consignor and the consignee. All out-of-state nurseries must file with the State Entomologist a copy of their valid inspection certificate, pay $1.00, and obtain a license good for one year from date of issue, before shipping stock into the State. Each dealer and agent selling or soliciting sales of nursery stock in Indiana must pay $1.00, and obtain a license from the State Entomologist.

FRANK N. WALLACE, *State Entomologist,* Department of Conservation, Indianapolis, Ind.

Iowa. Copy of inspection certificate must be filed with and approved by the State Entomologist, and must accompany each shipment into the State.

Quarantine against the European corn borer prohibits all the usual host plants entering the State from the infested areas in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, Ohio, and Michigan.

CARL J. DRAKE, *State Entomologist,* Ames, Iowa.

Kansas. Nurseries are inspected annually and all certificates and dealers' permits expire on June 1 following date of issue. Nursery stock from other states must be accompanied by a recognized certificate of inspection, and may be inspected in transit or at destination; if found infested, stock may be returned to consignor at his expense, treated or otherwise disposed of, as the inspector may direct.

Nurserymen both within or outside the State who sell nursery stock at retail through agents in Kansas shall file a list of such agents with addresses; said agents shall carry with them at all times, credentials of appointment from the nurseries which they represent and copies of inspection certificates issued to said nurseries.

All raspberry plants entering the State must be certified as being free from all diseases of the virus type, except so-called "mild mosaic" of black and purple raspberries, after two inspections the preceding growing season, with an interval of 30 days between inspections. Duplicate certificates of other states must be filed.

W. R. Martin, *Secretary, Entomological Commission*, Topeka, Kans.

Kentucky. Kentucky nurseries are inspected annually and certificates are issued when stock is found free from dangerous pests. All nurserymen, resident or non-resident, must file annually, credentials at this office and if in good standing receive a permit on payment of a fee of $5.00.

Agents and dealers must file credentials annually, including names of "nurseries, nurserymen, or persons represented," and on payment of a fee of $5.00 are issued a permit. Agents while soliciting orders must carry their permits to show prospective buyers, county officials, or agents of the State Entomologist, on demand. Quarantines are provided for.

W. A. Price, *State Entomologist*, Lexington, Ky.

Louisiana. Before shipping nursery stock into Louisiana, application must be made to the Entomologist for permit, by filing copy of valid certificate and order for certificate tags, accompanied by money to pay for them (price on application). The Louisiana tag and the inspection certificate of the State where the stock was grown must both accompany each shipment. The invoice stub of each permit tag must be filed with the Entomologist once a week, showing the number and varieties of plants shipped.

W. E. Anderson, *State Entomologist*, Department of Agriculture, Baton Rouge, La.

Maine. All individuals or firms selling or soliciting sales of nursery stock that they have not grown shall annually obtain a

license from the State Horticulturist by paying a fee of $5.00. All stock entering the State shall bear on each box or package a valid inspection certificate; such stock may be inspected at destination and if found infested with dangerous pests may be destroyed or returned to the consignor.

Quarantine prohibits entrance of currant or gooseberry plants. Five-leafed pines cannot enter without a permit from the Forest Commissioner.

Robert F. Chandler, *State Horticulturist,* Augusta, Me.

Maryland. Nurseries are inspected twice each year. Nursery stock coming from blocks that show evidence of San José scale must be hand-inspected to eliminate visibly infested stock, and the rest fumigated before shipment. Shipments entering the State must bear certificates of inspection, besides names of consignor and consignee. Duplicate certificate should be filed with the State Entomologist.

Quarantines prohibit the shipment of five-leafed pines, currants and gooseberries from New York, the New England States, Pennsylvauia, New Jersey, Michigan, Wisconsin, Minnesota and Washington; also into the non-infested counties of Maryland, of any nursery stock of peach or sweet cherry from areas infested with the Oriental peach moth.

Ernest N. Cory, *State Entomologist,* College Park, Md.

Massachusetts. All growers and agents who sell nursery stock for delivery within the State must have a grower's certificate or an agent's license, and a copy of such certificate or license must accompany each car, box or package of stock shipped or delivered. Agents must apply to Director, Division of Plant Pest Control, Boston, Mass., and file list of nursery firms from which they purchase stock before receiving agent's license. Authority is granted to inspect at destination all stock entering the State, and if found infested it may be destroyed, treated, or returned to the consignor at his expense.

Quarantines prohibit Ribes from entering the State except under permit.

R. H. Allen, *Director, Division of Plant Pest Control,* 136 State House, Boston, Mass.

Michigan. All nurseries are inspected annually. Each out-of-state nurseryman who sells in Michigan through personal representatives must file a certified copy of his original certificate, and pay a fee of $5.00 to obtain a license permitting him to ship stock into the State. Each shipment must bear an exact copy of the inspection certificate issued in the state from which the stock was shipped, names and addresses of both consignor and consignee,

and a statement showing the general nature of the contents. Out-of-state nurserymen wishing to sell nursery stock in Michigan through catalogue must file copies of their original certificates of inspection. All nursery stock entering the State, except conifers and herbaceous plants, subject to the attack of San José scale must be fumigated with hydrocyanic acid gas in the usual manner and must bear a certificate from the shipper that such fumigation has been given.

The law and quarantine regulations prohibit the entrance of all barberries subject to the attack of black stem rust of grains; all chestnut trees; all trees and plants from areas infested by the Japanese beetle and European corn borer, except in compliance with Federal regulations; all raspberries unless bearing certificates that the plants have been properly inspected for virus diseases, as under Rules and Regulations No. 273. Currants and gooseberries shipped into Michigan must be accompanied by a control area permit issued by the Commissioner of Agriculture.

E. C. Mandenburg, *In Charge of Orchard and Nursery Inspection,* Department of Agriculture, Lansing, Mich.

Minnesota. All shipments must be accompanied by a valid certificate of inspection on the outside of each package. A copy of this certificate must be filed with the state inspector before nursery stock is shipped into the State. No filing fee is required. A license is not required for agents or salesmen.

Minnesota Quarantine No. 5 prohibits the entry of alfalfa hay and other hay of all kinds and cereal straw if grown or stored in the State of Utah and certain portions of the States of Idaho, Colorado, Nevada, California, Oregon, and Wyoming, on account of the alfalfa weevil.

Minnesota Quarantine No. 6 requires that all raspberry plants shipped into Minnesota must be accompanied by a valid certificate showing that the plants have been inspected and found apparently free from mosaic and other virus diseases. A special affidavit signed by the shipper may be accepted in lieu of such certificate on each package.

The term "nursery stock" includes all wild and cultivated trees, shrubs, perennial vines, small fruit plants, perennial roots, rhizomes, herbaceous perennials, cuttings, buds, grafts and scions for or capable of propagation. A certificate of inspection is not required for greenhouse or house-grown plants, bedding plants, herbaceous annuals, vegetable plants, bulbs, corms and tubers.

All nursery stock for shipment into Minnesota must comply with the requirements of quarantines promulgated by the Federal Plant Quarantine and Control Administration.

A. G. Ruggles, *State Entomologist,* University Farm, St. Paul, Minn.

Mississippi. Each package of nursery stock shipped into Mississippi must have attached to it a Mississippi permit tag and a certificate issued by the state inspection official of the state where grown. Also, there must be a statement or tag on each shipment showing the name and address of both consignee and consignor, the general nature and quantity of the contents, and the name of the locality where grown. The permit tags may be obtained at actual cost from the nursery inspector, at the Agricultural and Mechanical College, Miss., after a satisfactory certificate of inspection issued by the duly authorized state official has been filed with him. The proprietor or manager of the nursery or greenhouse must sign and file with the plant board an agreement with reference to complying with the Mississippi law in shipping nursery stock into Mississippi.

All plants capable of defoliation must be defoliated.

Plants infected with root knot (caused by nematodes), crown gall or showing any insect pest or disease or markings thereof, must not be shipped into Mississippi.

Each agent or salesman representing nursery firms is required to register with and obtain an agent's certificate from the nursery inspector before selling, delivering, or taking orders for nursery stock in Mississippi. Stock shipped to nursery agents for delivery in Mississippi must be packed in individual packages, and each of these accompanied by a Mississippi permit tag.

Each permit tag has an invoice stub with carbonized sheet attached. On using a Mississippi permit tag, the nurseryman must immediately mail to the nursery inspector, the Agricultural and Mechanical College, Miss., the invoice stub for that tag (with carbonized sheet attached and filled in) showing the name and address of the consignee and an itemized list of plants in the shipment.

Mutilated, spoiled, and unused permit tags must be returned to the Mississippi nursery inspector. All permit tags remaining on hand at the close of the season must be returned.

A circular explaining the requirements in more detail will be sent, on request to—

George F. Arnold, *Nursery Inspector,* Agricultural and Mechanical College, Miss.

Missouri. Outside nurseries must file necessary papers including certificate and apply for a permit certificate which will be issued on payment of a $5.00 fee. All agents or salesmen must apply for agent's certificate. Each package of nursery stock entering the State must bear the names of both consignor and consignee, statement of contents, and a certificate showing that the stock therein contained has been inspected where grown by a duly authorized inspector and found to be apparently free from danger-

ously injurious insect pests and plant diseases. Transportation companies are not permitted to deliver nursery stock unless so labeled.

K. C. SULLIVAN, *Plant Commissioner*, Jefferson City, Mo.

Montana. All nursery stock entering the State must be unpacked and inspected at one of the following designated quarantine stations: Billings, Butte, Miles City, Missoula, Sanders or Fairview. All shipments entering the State are subject to inspection with fees as follows: licensed nurseries, car lots, $10, smaller lots proportionate; unlicensed nurseries, ten per cent of invoice price shipment with minimum of 50 cents per package. Notice of shipment including list of stock and names of transportation company, consignor and consignee must be sent to the Chief, Division of Horticulture, Missoula, Mont., five days before shipment.

Nurserymen are required to pay an annual fee of $25 and file a bond of $1,000 in favor of the State of Montana; this includes licenses for all Montana agents. Agents for unlicensed nurseries must pay an annual fee of $10 and file bonds of $1,000.

Quarantines prohibit the entrance of the common barberry, black currant, five-leafed pine and currant and gooseberry plants.

GEORGE L. KNIGHT, *Chief, Division of Horticulture*, Missoula, Mont.

Nebraska. Non-resident nurserymen, dealers, or other persons wishing to ship nursery stock into Nebraska must file a duplicate certified copy of their original certificate with the State Department of Agriculture. If this certificate is approved by the Department of Agriculture, they will be issued a permit allowing them to ship nursery stock into this State during the period that such original certificate issued by the State in which they reside or are doing business is in force. No fee is charged for the non-resident dealer's or nurseryman's permit. Each shipment of nursery stock coming into the State must be plainly and legibly marked in a conspicuous place with a statement showing: (a) the name and address of the consignor; (b) the name and address of the consignee; (c) the general nature of the contents; (d) the name of locality where grown; and (e) a certificate of inspection from the proper official of the state, territory, district or country from which it was shipped. All agents selling nursery stock or soliciting orders for nursery stock for any nurseryman or dealer located either within or without the State of Nebraska shall be required to secure and carry an agent's permit. The fee for this permit is $1.00.

Any prohibited insect pest or plant disease, plant product or other substance or thing, brought into the State in violation of any

regulation of the State Department of Agriculture or any Federal Quarantine, shall at the expense of the owner be either destroyed, returned to the consignor, or otherwise disposed of as the Department of Agriculture may direct.

H. J. McLaughlin, *Secretary;* L. M. Gates, *Inspector,* State Department of Agriculture, Lincoln, Neb.

Nevada. All nursery stock entering the State must bear on each car, bale, or package a copy of a valid official inspection certificate, and names of consignor and consignee. Transportation companies shall not deliver nursery stock lacking such certificate.

Quarantine prohibits entry of any pine trees, currant or gooseberry plants or cuttings from east of the Mississippi River or from foreign countries, and of fruit trees, and fresh fruits and their boxes or containers, from any States infested by the Oriental fruit moth.

George G. Schweis, *Director, Division of Plant Industry,* 7 Cladianos Building, Reno, Nev.

New Hampshire. All nursery stock entering this State must bear on each container a copy of a valid inspection certificate.

Quarantines prohibit the entrance of currants or gooseberries into any part of the State, except an area in the northernmost part of the State, beginning with the towns of Stratford, Odell, Millsfield and Errol; require permit for importation of any five-leafed pines, and special certificate from state of origin, in accordance with Federal regulations; prohibit entry of plants susceptible to attack by the European corn borer, the gipsy moth, and the browntail moth from infested regions into uninfested territory, except with proper certificate; prohibit entry of plants susceptible to attack of the satin moth from infested regions into uninfested territory.

W. C. O'Kane, *Deputy Commissioner of Agriculture,* Durham, N. H.

New Jersey. Shipments into the State must be accompanied by a certificate of inspection of current date, or copy thereof, attached to each car or parcel, together with a statement from the shipper that the stock therein is a part of the stock inspected, and stating whether such stock has been fumigated with hydrocyanic gas. It shall be the duty of all carriers to refuse for transportation within the State all stock not accompanied by a certificate of inspection. All stock coming into the State may be detained for examination, wherever found, by the Chief of the Bureau of Statistics and Inspection, and if found to be infested with any insects or plant diseases, injurious or liable to become so, will be destroyed.

It shall be the duty of every nurseryman, or other person who imports plant material of any kind from without the State, and every transportation company or other carrier for hire that brings plant material from without the State for delivery to any person, persons, firm, or corporation within the State, to notify the Chief of the Bureau of Statistics and Inspection of such shipment prior to, or within 24 hours after, its arrival. Such notice shall state the kind, the quantity of plant material, the name and address of the shipper, the date of shipment, and if from a foreign country, the name of the country or district in which the shipment originated, the port of entry, and the approximate date of arrival at said port. If the Bureau Chief has any reason to suspect the presence of a dangerous pest, he may order the examination of every package of such material, in transit or at the point of delivery, and shall not authorize its acceptance or delivery until he is satisfied that no dangerous pest is present.

HARRY B. WEISS, *Chief, Bureau of Statistics and Inspection,* State Department of Agriculture, Trenton, N. J.

New Mexico. Nurserymen in other States desiring to ship nursery stock into New Mexico must each file a copy of their certificate of inspection signed with pen by the proper official, with a filing fee of $5.00, and secure a permit-certificate bearing the facsimile signature of the Deputy Inspector, which must accompany each shipment of nursery stock into the State. With each permit-certificate granted, 100 tags will be supplied free of charge. Additional tags may be purchased at the following prices:

50 tags	$1.00	200 tags	$2.00
100 tags	1.25	500 tags	4.25

The following quarantines affect the shipment of nursery stock: Quarantine No. 7, white pines and Ribes; Quarantine No. 8, nursery stock, farm products, and forage crops.

R. F. CRAWFORD, *Plant Quarantine and Regulatory Office,* State College, N. M.

New York. Nursery stock cannot enter the State or be moved within the State unless a valid certificate is attached issued by the New York State Department of Agriculture and Markets, or by the State in which the shipment originated. Transportation companies and all persons bringing nursery stock into the State from other States, must send notice to the Department of Agriculture and Markets. Blanks will be furnished for such notices. An exact copy of the certificate must be attached to each package sent by mail. Stock received from abroad or from other States unaccompanied by a valid certificate of inspection must not be unpacked or distributed until after inspection or release by the Department of Agriculture and Markets.

Quarantines prohibit the entrance of five-leafed pine trees into the State except when such shipments comply with Federal Quarantine 63; also of Christmas trees and woody greens from New England except from those areas lightly or not infested by gipsy moth (Federal certificates must accompany shipments from the lightly infested area); of raspberry plants unless apparently free from mosaic diseases and are so certified after two inspections and the removal of all diseased plants, as is practiced in New York State. Currants and gooseberries cannot be grown in certain pine-growing areas of the State and permits must be obtained to ship them into the State. Name and address of consignee must be given in application.

B. D. Van Buren, *Director, Bureau of Plant Industry,* Department of Agriculture and Markets, Albany, N. Y.

North Carolina. Nursery stock may enter the State only when shipments bear North Carolina official permit tags, which will be supplied at cost on request, and the filing of a duplicate inspection certificate.

Quarantines prohibit the entrance of five-leafed pines and Ribes except in accordance with Federal regulations.

R. W. Leiby, *Entomologist,* State Department of Agriculture, Raleigh, N. C.

North Dakota. Nursery stock entering the State must bear inspection certificates. Every person employing agents or salesmen or who solicits for the sale of nursery stock, must file a duplicate inspection certificate.

Director, *North Dakota Agricultural Experiment Station,* Agricultural College, N. D.

Ohio. Out-of-state nurserymen must file copies of their inspection certificates and obtain an Ohio certificate permitting them to solicit orders for nursery stock. Each dealer within or without the State shall obtain annually a dealer's certificate, by furnishing an affidavit that he will buy and sell only inspected stock and will maintain with the Secretary of Agriculture a list of all sources from which he obtains nursery stock. Each affidavit shall be accompanied by a fee of $5.00. All agents soliciting orders for nursery stock shall file annually a statement that he will sell only inspected stock, and pay a fee of $1.00. He shall carry an agent's certificate and a copy of the certificate held by his principal.

Each shipment entering the State shall be accompanied by a tag or poster giving an exact copy of the valid certificate. Altered certificates are prohibited.

Quarantines prohibit the entrance or shipment within the State of the common barberry and its horticultural varieties, and the common host plants of the European corn borer.

E. C. Cotton, *Chief, Division of Plant Industry,* Department of Agriculture, Columbus, Ohio.

Oklahoma. Nursery stock entering the State must bear on each package of each shipment an inspection certificate. Nurserymen must each file a duplicate copy of their valid inspection certificate, and furnish a surety bond of $1,000 in favor of the State Board of Agriculture. A permit will be issued on payment of the fee of $5.00, and a copy of this permit must be attached to all shipments entering the State of Oklahoma.

All dealers within or outside the State must attach to each package of each shipment a copy of the dealer's certificate issued to them by the Board of Agriculture.

R. E. Montgomery, *State Nursery Inspector,* Oklahoma City, Okla.

Oregon. Shipments of nursery stock entering the State must be plainly marked, with names and addresses of both consignor and consignee, name of state, territory, or country where grown, and nature of contents. All shipments are inspected, and the unlicensed sale or distribution of nursery stock is unlawful. Nurserymen must apply for license and pay a fee of $15. The fee for an agent, solicitor, or salesman is $1.00.

Quarantines prohibit the entrance of grape vines; all species and varieties of chestnut and chinquapin; all hazel and filbert trees, plants, cuttings, and scions from the Eastern states; all species and varieties, including the flowering forms of peach, almond, nectarine, apricot, plum, cherry, quince, pear, and apple trees or parts thereof from the Eastern states.

Charles A. Cole, *Secretary,* State Board of Horticulture, Portland, Ore.

Pennsylvania. Each nurseryman from outside of the State must file with the Director of the Bureau of Plant Industry a duplicate copy of his valid inspection certificate, signed in person by the state inspection official in charge, and supply a statement giving the exact acreage of nursery stock he is growing, as well as the acreage being grown for him under contract. Upon compliance with these regulations a certificate is issued that must be received before stock is shipped into the State. Dealers are granted certificates on application and receipt of a statement from each that he will buy stock only from nurseries holding valid certificates of inspection. Agents soliciting for the sale of nursery stock in the State must obtain and carry agents' duplicate certifi-

cates. All shipments of nursery stock entering the State will be rejected unless accompanied by certificates of inspection.

Interstate quarantines regulate the entrance of Ribes, five-leafed pines, all barberry plants except Japanese barberry, and shipments of Christmas trees or woody greenery from the gipsy moth districts of New England and Canada.

R. H. Bell, *Director, Bureau of Plant Industry*, Harrisburg, Pa.

Rhode Island. All stock entering the State must bear a valid official certificate of inspection, but is subject to further inspection and may be destroyed or returned to the consignor if found infested. Agents must obtain agents' licenses, on stating where they expect to purchase their stock.

Five-leafed pines and Ribes can be shipped into the State or planted in certain parts of the State only on permission. Planting of black currant and flowering currant is prohibited.

A. E. Stene, *State Entomologist*, State House, Providence, R. I.

South Carolina. Each package of nursery stock entering the State must bear a permit tag of the South Carolina State Crop Pest Commission, which may be obtained at cost by filing a duplicate certificate of inspection and fumigation.

Quarantines prohibit the entrance of five-leafed pines, currants, gooseberries and all host plants of the European corn borer except when shipped in conformity with Federal regulations. Citrus stock is allowed to enter only by special permit. Fumigation of host plants of San José scale is required.

South Carolina State Crop Pest Commission, Clemson College, S. C.

South Dakota. Out-of-state dealers may obtain certificates permitting them to solicit and fill orders in the State, by filing with the Secretary of Agriculture a certified copy of their official inspection certificates and by paying a fee of $1.00 each. All agents shall likewise obtain and carry agents' certificates bearing copies of the certificates held by their principals, and paying fees of $1.00 each.

Quarantines prohibit the entrance of all five-leafed pines and Ribes; of all poplars and willows from areas infested by the satin moth; all host plants of the European corn borer.

Frank D. Kriebs, *Secretary of Agriculture*, Pierre, S. D.; R. W. Vance, *Nursery Inspector*, Brookings, S. D.

Tennessee. Out-of-state nurseries must file duplicate inspection certificates and the following agreement regarding fumigation:

"We, the undersigned, agree to fumigate with hydrocyanic acid gas, according to the required strength, all nursery stock subject to attack from San José scale and other dangerous insect pests. We also agree to attach a fumigation tag to each and every shipment going into the State of Tennessee."

Every shipment must bear a valid inspection certificate and a fumigation tag, and failure to comply with these requirements subjects the stock to confiscation.

Nursery agents and dealers must file sworn statements on official Tennessee blanks, which will be supplied. Each agent operating in Tennessee, and each dealer or jobber, is required to secure a license.

Nurserymen selling trees under contract to prune and spray the same for a period of years are required to take out a bond of $5,000 before selling trees under such special contract.

State quarantines prohibit the entrance of all varieties of barberry, except *Berberis thunbergii;* and all varieties of chestnut and chinquapin from all States where the chestnut blight occurs. Other restrictions apply to the Japanese beetle, the European corn borer, gipsy moth, sweet potato weevil and pink bollworm of cotton. Peach and pecan seedlings are allowed entrance only by special permit for experimental purposes.

G. M. Bentley, *State Entomologist and Plant Pathologist,* Knoxville, Tenn.

Texas. Nurserymen, florists, and others who desire to make shipments of nursery stock into Texas, should apply to the State Department of Agriculture, Austin, Texas, for a Texas permit. The application should be accompanied by a certified copy of certificate of inspection from the state inspector of the state in which the stock to be shipped is located, together with a registration fee of $5.00. The fee must be remitted in the form of postoffice money order, cashier's check, or bank draft. It will also be necessary for the applicant to sign an agreement to comply with the Texas regulations. The proper form for this signature will be sent upon request. Permits are issued annually and expire August 31 of each year. This general certificate does not cover citrus nursery stock. Any individual desiring to make shipments of citrus nursery stock into the State should communicate directly with the Commissioner of Agriculture.

All shipments of nursery or floral stock originating outside of the state must bear shipping tags showing the exact copy of certificate of inspection from the state inspector of the State in which the shipments originate; and in addition thereto must have tags showing the exact copy of the Texas permit. The Department of Agriculture does not furnish the Texas permit tags, and the shipper should have them printed from the original certificate. Common carriers are prohibited by law from releasing shipments of nursery stock that are untagged in accordance with these regulations.

Nurserymen and florists of all States who ship nursery and floral stock into Texas are requested to file with the Department of Agriculture a copy of invoice or memorandum of each and

every shipment of stock made into the State, giving the date, consignor, consignee, and a list of stock shipped. The price need not be given.

Those intending to ship orange and citrus seed of all kinds into Texas must furnish the Texas department with a certified statement from their state plant board that the seed was gathered from citrus-canker-free territory, and also an affidavit that the seeds to be shipped were treated in a corrosive sublimate solution of a strength of one to 1,000.

Agents or dealers operating in Texas for nurserymen and florists outside of the State must procure proper credentials from the nurserymen they represent. The form for this credential approved by the Commissioner of Agriculture is furnished free of charge. Each agent or dealer must be prepared to present such credentials at all times.

Dealers are classed as nurserymen and are required to take out permits. Greenhouses and greenhouse plants are included for inspection by the Texas laws.

J. S. WOODWARD, *Chief Nursery Inspector,* Department of Agriculture, Austin, Texas.

Utah. Out-of-state nurserymen must file with the Board of Agriculture a valid official inspection certificate and names of their agents in Utah, and obtain (without fee) an annual license; file a bond for $500 that they will comply with the law and to cover cost of inspection, fumigation, or destruction of stock shipped into the State or sold by their agents. Agents and salesmen representing out-of-state firms must carry proper credentials.

All nursery stock entering the State must bear a valid official inspection certificate and an official certificate that the shipment has been given a cyanide fumigation for 45 minutes at the rate of one ounce to each 100 cubic feet of enclosed space. Also a notice of each shipment giving duplicate invoice, list of contents, date, and names of both consignor and consignee must be mailed to the State Agricultural Inspector. Any out-of-state shipment not bearing the proper license and certificate tags will be placed in quarantine and inspected and disinfected at the owner's expense.

F. E. STEPHENS, *State Agricultural Inspector,* State Board of Agriculture, Salt Lake City, Utah.

Vermont. All nursery stock entering the State must bear valid official inspection certificates and the names and post office addresses of both consignor and consignee.

Quarantines restrict the free movement of raspberry plants on account of mosaic, leaf roll and rosette, hosts of the European corn borer, and all uninspected and non-nursery grown trees and forest products on account of the gipsy and brown-tail moths.

M. B. CUMMINGS, *State Nursery Inspector,* Burlington, Vt.

Virginia. All nurseries must file valid inspection certificates with the State Entomologist for the current season and pay a registration fee of $10 for principals; duplicates for agents' use, $1.00 each. Checks should be made payable to the *Treasurer of Virginia.* Official state tags purchased from the State Entomologist must accompany each package of stock entering the State. Registration certificates expire annually on August 31.

Christmas greens originating in the States of Maine, New Hampshire, Massachusetts, Vermont, Connecticut and Rhode Island are prohibited on account of the gipsy and brown-tail moths, unless each shipment is accompanied by a certificate showing that it has been inspected officially and found to be free from such pests. Japanese beetle quarantine covers several small areas and conforms with the Federal quarantine.

G. T. French, *State Entomologist,* Department of Agriculture, Room 1112, State Office Building, Richmond, Va.

Washington. No person, firm or corporation shall sell, solicit sales, or distribute nursery stock except berry plants, without first obtaining a license to do so from the Director of Agriculture. The license fee is $5.00 for nurserymen who grow all the stock they sell, $15 for other nurserymen, dealers, brokers and landscape architects, and $1.00 for agents, salesmen and solicitors. All licenses expire July 1. All nursery stock entering the State shall have contents, names and addresses of consignor and consignee, and name of state, territory, or country where the stock was grown, plainly marked on each car, box, bale or package. The State is divided into eleven horticultural districts with an inspector-at-large in charge of each district. Notice must be sent to one of these inspectors of any shipments arriving without the proper license certificate or labels, and the said inspectors are authorized to inspect such shipments and charge such fees as may be fixed by the Director of Agriculture.

Quarantines prohibit the entrance of five-leafed pines, currants, gooseberries, chestnut, chinquapin, hazel, filbert, and carriers of the European corn borer, peach yellows, and Oriental fruit moth.

George E. Harter, *Supervisor of Horticulture,* Olympia, Wash.

West Virginia. All nursery stock entering the State must bear a valid certificate of inspection and a West Virginia permit tag. No nursery stock shall be sold, offered for sale or delivered, without first obtaining from the Commissioner of Agriculture a certificate of registration; annual fee, $20.

W. E. Rumsey, *State Entomologist,* Morgantown, W. Va.

Wisconsin. Each out-of-state nurseryman must file a valid certificate of inspection and obtain a State license before shipping

stock into the State. Each car, or package, must bear certificate tags. Each agent selling nursery stock in the State must carry an agent's duplicate certificate bearing the same number and date as that of his principal. No fees are charged except for resident nurserymen.

Quarantines prohibit entrance of all five-leafed pines and all barberry bushes, except Japanese barberry, and host plants of European corn borer from infested areas; nursery stock from gipsy moth infested areas except under Federal certificate; cranberry plants; raspberry plants unless certified to a special inspection for virus diseases.

E. L. CHAMBERS, *State Entomologist,* Madison, Wis.

Wyoming. Each out-of-state nurseryman must file a valid certificate of inspection and deposit a fee of $15 and receive a license valid until the following July 1. Authorized shipping tags are furnished at cost, and carriers are forbidden to deliver unless each shipment bears such a tag.

Quarantines prohibit entrance of all five-leafed pines, currants and gooseberries.

A. G. STEPHENS, *State Department of Agriculture,* Cheyenne, Wyo.

OFFICERS IN CHARGE OF INSPECTION AND QUARANTINE SERVICE

Alabama ....B. P. Livingston, Chief, Division of Plant Industry, Montgomery, Ala.

Arizona ....O. C. Bartlett, State Entomologist, Phoenix, Ariz.

Arkansas ....P. H. Millar, Chief Inspector, Little Rock, Ark.

California ....A. C. Fleury, Senior Quarantine Supervisor, Sacramento, Cal.

Colorado ....C. P. Gillette, State Entomologist, Fort Collins, Colo.

Connecticut ......W. E. Britton, State Entomologist, New Haven, Conn.

Delaware ....Ralph C. Wilson, Secretary, State Board of Agriculture, Dover, Del.

Florida ....Nursery Inspector, State Plant Board, Gainesville, Fla.

Georgia ....M. S. Yeomans, State Entomologist, Atlanta, Ga.

Idaho ....M. L. Dean, Director, Bureau of Plant Industry, Boise, Idaho.

Illinois ....P. A. Glenn, Chief Inspector, Division of Plant Industry, Urbana, Ill.

Indiana ....Frank N. Wallace, State Entomologist, Indianapolis, Ind.

Iowa ....Carl J. Drake, State Entomologist, Ames, Iowa.

Kansas ....W. R. Martin, Secretary, Entomological Commission, Topeka, Kans.

Kentucky ....W. A. Price, State Entomologist, Lexington, Ky.

Louisiana ....W. E. Anderson, State Entomologist, Baton Rouge, La.

Maine ....Robert F. Chandler, State Horticulturist, Augusta, Me.

Maryland ....E. N. Cory, State Entomologist, College Park, Md.

Massachusetts ....R. H. Allen, Director, Division of Plant Pest Control, State House, Boston, Mass.

Michigan ....E. C. Mandenberg, In Charge of Orchard and Nursery Inspection, Department of Agriculture, Lansing, Mich.

Minnesota ....A. G. Ruggles, State Entomologist, University Farm, St. Paul, Minn.

Mississippi ......Geo. F. Arnold, Nursery Inspector, Agricultural College, Miss.

Missouri ....K. C. Sullivan, Plant Commissioner, Jefferson City, Mo.

Montana ....George L. Knight, Chief Division of Horticulture, Missoula, Mont.

Nebraska ....H. J. McLaughlin, Secretary; L. M. Gates, Inspector, State Department of Agriculture, Lincoln, Nebr.

Nevada ....George G. Schweis, Director, Division of Plant Industry, 7 Cladianos Building, Reno, Nev.

New Hampshire ..W. C. O'Kane, Deputy Commissioner of Agriculture, Durham, N. H.

New Jersey ......Harry B. Weiss, Chief, Bureau of Statistics and Inspection, State Department of Agriculture, Trenton, N. J.

New Mexico .....R. F. Crawford, Plant Quarantine and Regulatory Office, State College, N. Mex.

New York ....B. D. Van Buren, Director, Bureau of Plant Industry, Department of Agriculture and Markets, Albany, N. Y.

North Carolina ..R. W. Leiby, Entomologist, State Department of Agriculture, Raleigh, N. C.

North Dakota ....Director, Experiment Station, Agricultural College, N. D.

Ohio ....E. C. Cotton, Chief, Division of Plant Industry, Department of Agriculture, Columbus, O.

Oklahoma ....R. E. Montgomery, State Nursery Inspector, Oklahoma City, Okla.

Oregon ....Charles A. Cole, Secretary, State Board of Horticulture, Portland, Ore.

Pennsylvania	R. H. Bell, Director, Bureau of Plant Industry, Harrisburg, Pa.
Rhode Island	A. E. Stene, State Entomologist, State House, Providence, R. I.
South Carolina	South Carolina State Crop Pest Commission, Clemson College, S. C.
South Dakota	Frank D. Kriebs, Secretary of Agriculture, Pierre, S. D. R. W. Vance, Nursery Inspector, Brookings, S. D.
Tennessee	G. M. Bentley, State Entomologist and Plant Pathologist, Knoxville, Tenn.
Texas	J. S. Woodward, Chief Nursery Inspector, Department of Agriculture, Austin, Tex.
Utah	F. E. Stephens, State Agricultural Inspector, State Board of Agriculture, Salt Lake City, Utah.
Vermont	M. B. Cummings, State Nursery Inspector, Burlington, Vt.
Virginia	G. T. French, State Entomologist, Richmond, Va.
Washington	George E. Harter, Supervisor of Horticulture, Olympia, Wash.
West Virginia	W. E. Rumsey, State Entomologist, Morgantown, W. Va.
Wisconsin	E. L. Chambers, State Entomologist, Madison, Wis.
Wyoming	A. G. Stephens, State Department of Agriculture, Cheyenne, Wyo.
Federal Quarantines and District of Columbia	Plant Quarantine and Control Administration, U. S. Department of Agriculture, Washington, D. C.
Dominion of Canada	L. S. McLaine, Secretary, Destructive Insect and Pest Act Advisory Board, Department of Agriculture, Ottawa, Can.

Circular 72 July 15, 1930

Connecticut Agricultural Experiment Station
New Haven

QUARANTINE REGULATIONS AFFECTING THE TRANSPORTATION OF NURSERY STOCK IN CONNECTICUT

W. E. Britton

Six pests in Connecticut are now the subjects of State quarantines and five of them are covered by Federal quarantines which nearly coincide with the State quarantines. As each of these quarantines affects in some measure the shipment and transportation of nursery stock between points within Connecticut or to points outside the State, every nurseryman should be familiar with their chief provisions and requirements. This circular has been prepared to supply this information in simplified form for the convenience of Connecticut nurserymen.

Present State Quarantines

Pest	State quarantine	Federal quarantine	Remarks
Gipsy moth	14	45	State and Federal quarantines coincide.
Satin moth	19	53	" " " " "
European corn borer	24	43	" " " " "
Japanese beetle	20	48	Federal quarantine covers entire State. State quarantine covers generally infested area.
Asiatic beetle	22	..	No Federal quarantine. State quarantine on small areas in New Haven and West Haven.
White pine blister rust	*	63	Entire State covered by Federal quarantine.

* State quarantines exist only around ten nurseries attempting to grow white pines. See Circular 70.

In all except the satin moth quarantine, special certificates are required, and the following pages show where to apply for inspection and certification. The Federal satin moth quarantine prohibits transporting or shipping poplar and willows outside of the quarantined area. The maps show the areas now under quarantine.

GIPSY MOTH

The gipsy moth quarantine, State and Federal, covers the eastern two-thirds of the State 'and includes two areas, known as generally infested and lightly infested, as shown on the

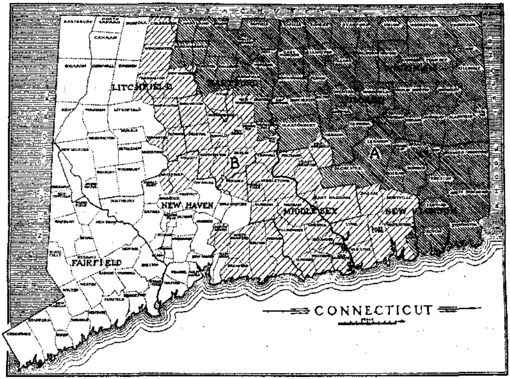

FIGURE 13. Map of Connecticut showing present quarantined areas. A, generally infested; B, lightly infested.

accompanying map, Figure 13. All shipments of woody field grown nursery stock to be moved from the generally infested area into the lightly infested area and from both areas into the free area must have a special gipsy moth inspection and certificate. For the most part, these inspections are made and the certificates granted by Federal inspectors in immediate charge of Dr. J. N. Summers, 408 Atlantic Ave., Boston, Mass. The inspectors working in Connecticut are as follows:

W. H. SHINKWIN, Box 260, telephone 46, Westfield, Mass., covers the towns of *Suffield, Windsor* and *Windsor Locks,* in Hartford County.

C. M. Emerson, Box 109, telephone 8-1119, Hartford, remainder of *Hartford County, Middlesex County*, all towns in *Litchfield* and *New Haven Counties* under quarantine, *Colchester, Lyme* and *Old Lyme* in New London County and *Somers, Ellington, Bolton* and *Hebron* in Tolland County.

W. J. Ahearn, Box 63, telephone 4388, Westerly, R. I., the towns of *East Lyme, Waterford, New London, Stonington* and *North Stonington.*

J. F. Keough, 54 Moulton Court, telephone 1395, Willimantic, *Windham County* and the remaining towns in *New London* and *Tolland Counties.*

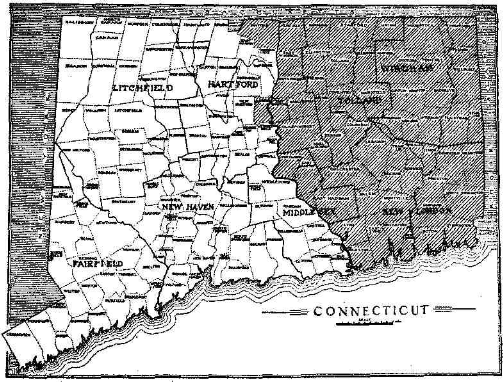

Figure 14. Map of Connecticut. Shaded portion is now under State and Federal quarantine on account of the satin moth.

SATIN MOTH

The satin moth caterpillars feed upon willow and poplar and pass the winter in inconspicuous cases in the crevices of the bark. On account of the great difficulty in detecting the presence of these cases, such stock will not be certified. The accompanying map, Figure 14, shows that the area quarantined includes all towns in Connecticut east of the Connecticut River and the towns of Hart-

ford and Suffield west of the river. As other towns have been found infested, the quarantined area will probably soon be extended. Willow and poplar trees are not allowed to move out of this area.

EUROPEAN CORN BORER

This quarantine concerns nurserymen in that all cut flowers and entire plants of chrysanthemum, hollyhock, aster, cosmos, zinnia,

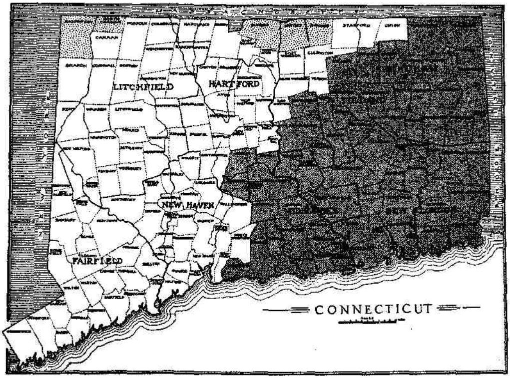

FIGURE 15. Map of Connecticut showing area under State and Federal quarantine on account of European corn borer. Shaded portion at right represents the two-generation area, and is part of the larger infestation extending over Rhode Island, eastern Massachusetts, New Hampshire and southwestern Maine. Lighter shaded portions in northwestern and north central part of the State represent the one-generation area, and are part of the large infestation of western Massachusetts, New York and westward.

gladiolus and dahlia, except gladiolus and dahlia bulbs without stems, must have certificates throughout the year in order to be moved from the two-generation area in eastern Connecticut, shown on the accompanying map, Figure 15.

For inspections and special certificates, apply to T. M. CANNON, 225 Trumbull St., telephone 6-1202, Hartford.

JAPANESE BEETLE

The entire State is now under Federal quarantine on account of this insect, and all shipments of nursery stock going into the free area must bear special certificates. A double row of towns along the coast in Fairfield and New Haven Counties as far east as the Branford line are under State quarantine and the same territory is designated in the Federal quarantine as the "generally infested area." Certificates are required on shipments to other towns in the State, called the "lightly infested area." See Figure 16.

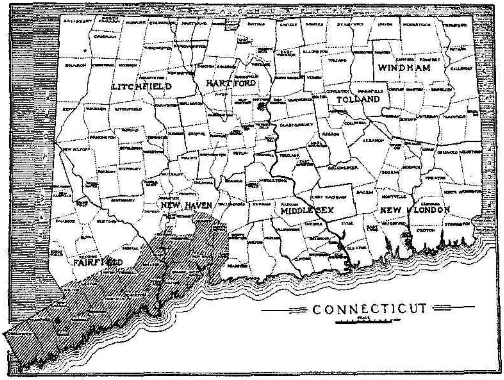

FIGURE 16. Map of Connecticut. Shaded areas indicate territory quarantined by the State on account of the Japanese beetle, and designated as the "generally infested area" in the Federal quarantine. Rest of the State is the "lightly infested area."

For inspections and certificates apply to J. PETER JOHNSON, Pierpont Building, telephone Derby 2974, Shelton, Conn.

ASIATIC BEETLE

The Federal quarantine against this insect has now been removed, but the State quarantine is still maintained on the following areas in New Haven and West Haven:

Westville area: Bounded by Whalley Avenue, Blake Street, Fitch Street, Dyer Street, Crescent Street, Whalley Avenue, Ellsworth Avenue, Derby Avenue, Boulevard, Oak Street, Forest Road, Florence

Avenue from a point about 400 feet west of Forest Road in a straight line northward to West Prospect Street to Whalley Avenue, and all territory within these boundaries, being partly in New Haven and partly in West Haven.

West Haven area: Bounded by Center Street, New Haven Harbor, Jones Street and in a straight line to Atwater Street and Campbell Avenue.

All nursery stock sent out of these areas must bear certificates.

For inspection and certificates, apply to W. E. BRITTON, *State Entomologist,* Connecticut Agricultural Experiment Station, telephone 5-6192, New Haven.

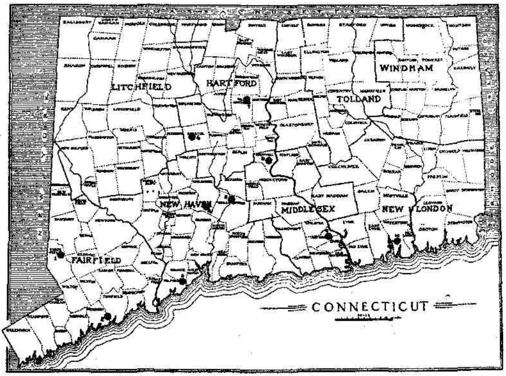

FIGURE 17. *Map of Connecticut. Black dots indicate location of Nursery Sanitation Zones, within which no currants or gooseberries may be grown.*

WHITE PINE BLISTER RUST

Connecticut has legally established control areas around ten nurseries so that five-leafed pines can be grown in blister rust free areas, the location of which are shown on the map, Figure 17. Five-leafed pines may be shipped out of the New England States and New York only when grown from seed in an area declared officially to be free from Ribes. Federal Quarantine 63 has recently been revised to permit the shipment of five-leafed pines anywhere within the region including the New England states and New York, but before this can be done, it is necessary to procure

control area permits (Federal form 415) for the shipment of Ribes and five-leafed pines. The European black currant is outlawed and no permits will be issued for this species.

For control area permits in Connecticut give name and address of consignee, with number of plants of each variety, and apply to W. E. Britton, *State Entomologist*, Agricultural Experiment Station, telephone 5-6192, New Haven.

For inspections of Ribes and pines to determine blister rust conditions and for the establishment of Ribes free areas, apply to J. E. Riley, Jr., Agricultural Experiment Station, telephone 5-6192, New Haven.

3591
17 JUN 193